MYCOTAXON

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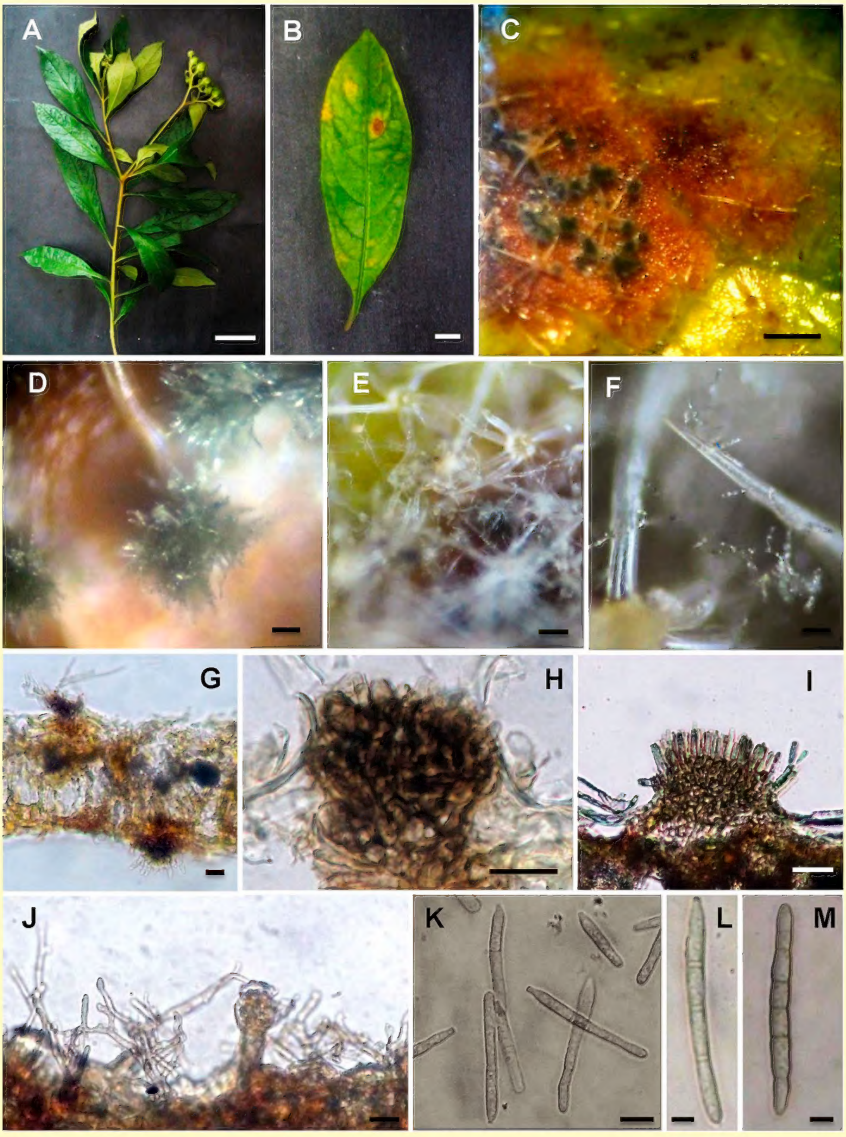

Pseudocercospora seropedicensis sp. nov.
on leaves of *Solanum asperum*
(Andrade & al.— PLATE 1, p. 123)

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MYCOTAXON

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Mycotaxon *for* October–December 2019 (i–xii + 491-740)
was issued on January 13, 2020

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Caliciopsis sambaibae J.L. Bezerra, M.P. Melo & Beserra
[MB 819221], p. 99
Neomyrmecridium asymmetricum R.F. Castañeda, Serrano & D. Sosa
[MB 831330], p. 157
Ochroconis terricola Xin Zhang & Y.L. Jiang
[MB 831137], p. 146
Paramycetinis R.H. Petersen
[IF 555792], p. 9
Paramycetinis austrobrevipes R.H. Petersen
[IF 555793], p. 11
Paramycetinis caulocystidiatus R.H. Petersen
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Phlebia wuliangshanensis C.L. Zhao
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Pseudocercospora seropedicensis Andrade, Medeiros & Inácio
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[IF 555734], p. 83
Pseudosperma flavorimosum Jabeen & Khalid
[MB 823494], p. 187

Tubakia koreana H.Y. Yun
[MB 814540], p. 225

Umbilicaria subg. *Papillophora* Davydov, Ahti & Sennikov
[MB 830067], p. 139
≡ "*Umbilicaria* subg. *Gyrophora*" sensu Davydov & al., Taxon 66: 1297. 2017.

Reviewers — volume one hundred thirty-five (1)

The Editors express their appreciation to the following individuals who have, prior to acceptance for publication, reviewed one or more of the papers prepared for this issue.

Ahmed M. Abdel-Azeem
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Jason M. Karakehian
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De-Wei Li
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Yoshitaka Ono
Clark L. Ovrebo
Shaun R. Pennycook
Christian Printzen
Gerhard Rambold
Gonzalo Romano
Keith A. Seifert
Wen-Xiu Sun

Corrigenda for Mycotaxon 135(1)

Cited below are mistakes present in files submitted for PDF conversion in the current issue but not detected by the authors until after the paper had gone to press.

p. 30, Fig. 15, label on "green" clade in *Pseudomarasmius*
FOR: *Ps. nitus-avis* READ: *Ps. nidus-avis*

p. 129, line 8 FOR: 2:1–388 READ: 2: 1–388

p. 129, line 21 FOR: v. 13, p. 365-371. READ: 13: 365-371.

p. 224, line 29 FOR: (Maddison & Maddison 2015*)*.
READ: (Maddison & Maddison 2015).

From the Editor-in-Chief

Mycotaxon, range extensions, and type descriptions — There are many places to publish brief "field guide" descriptions accompanying a photo of a species collected outside its reported range, but Mycotaxon is not one of them. For each range extension, Mycotaxon requires authors to provide a correct scientific name, a technical description based entirely on the specimens collected (without adding data the species is "supposed" to have but which the specimen lacks), a section listing the specimens examined and vouchered, illustrations, and a comparison of the similarities and differences between the new collections and previously published descriptions.

What we have perhaps NOT stressed enough is that researchers must first closely compare their find with the **type** description, even though it may not be possible to examine the actual type itself. Other critical literature to be consulted includes type studies and monographic treatments of the putative species. While field guides (such as the oft-cited Breitenbach & Kränzlin) are helpful in reaching a species identification, they cannot replace primary references for reliability. Remember that species are named based on the type collection and not on an ephemeral 'general' concept.

How big is that spore again? — Scale "bars" (lines indicating the relative size of a specimen or structure in a scientific illustration) should be unobtrusive (i.e. relatively narrow) and accurate. We urge all authors to "keep it simple" by selecting only a few dimensions divisible by 5 or 10. Measure macroscopic features in millimeters (using cm only when a feature is larger than 10 mm) and limit microscopic measurements to 5 µm (small spores), 10 µm (larger spores or cells), or 50 or 100 µm (complex hyphal tissues). Scales (and their accompanying structures) should lengthen or shorten as needed to match precisely the dimensions cited in the legend. Authors should group dimensions at the end of each legend for easy reference.

An acceptable legend ends with: "Scale bars: A–C = 500 µm; D, F = 10 µm; E,G,H = 5 µm."

An unacceptable legend ends with: "Scale bars: A = 488 µm; B = 503.5 µm; C = 425 µm; D = 6.8 µm; E = 3.2; F = 12.5 µm; G = 6.3 µm; B = 4.8 µm."

When your editors encounter manuscripts with scale information presented in the second format, they become very surly indeed.

Mycotaxon 135(1) contains 13 papers by 60 authors (representing 13 countries) as revised by 33 expert reviewers and the editors.

The 2020 January–March Mycotaxon proposes two new genera (*Paramycetinis* & *Pseudomarasmius*), one new subgenus (*Umbilicaria* subg. *Gyrophora*), and 12 species new to science representing *Caliciopsis* & *Pseudocercospora* from Brazil; *Neomyrmecridium* from Ecuador; *Ochroconis* & *Phlebia* from China;

Paramycetinis from Australia & New Zealand; *Pseudomarasmius* from Chile, China, and Costa Rica; *Pseudosperma* from Pakistan; and *Tubakia* from South Korea. We also offer four new combinations in *Pseudomarasmius*.

New species range extensions are reported for [basidiomycetes] *Agaricus, Steccherinum,* and *Typhula* for Turkey, *Gymnopus* for Pakistan, and [lichens] *Rinodina* for China. Also included are an excellent historical exploration of the nomenclature (and spelling!) of *Umbilicaria spodochroa* and a thoughtful comparison between *Pachyphlodes* and *Chromelosporium* anamorphs.

Mycotaxon 135(1) closes with the announcements of two mycobiota [now posted on www.mycotaxon.com] covering [1] macrofungi in Palestine and [2] white and pink-spored agarics in Bolivia.

Covid-19—This issue goes to press (late as usual, unfortunately) in the middle of a global endemic caused by a new corona-virus. The fallout from this plague will unfortunately alter our lives on many fronts beyond the current deaths and isolation we now face. Take heart, persevere, and strive ever upward. I close with these lines by Alicia Jo Rabins:

> "Through windows and screens
> We sing and raise a glass
> Simultaneous but not together.
> Oh my friends my beloved strangers
> I never knew our closeness
> Until it was gone."

For now— work safely apart; stay healthy together.

Lorelei Norvell (*Editor-in-Chief*)
14 April 2020

2020 Mycotaxon submission procedure

Prospective Mycotaxon authors should download the Mycotaxon 2020 guide, review & submission forms, and Mycotaxon sample manuscript by clicking the 'file download page' link on our Instructions to Authors page before preparing their manuscript. This page briefly summarizes our '4-step' submission process.

1—Peer review: Authors first contact peer reviewers (two for journal papers; three for mycobiota/fungae) before sending them formatted text & illustration files and the appropriate 2020 Mycotaxon journal or mycota reviewer comment form. Experts return revisions & comments to both the *Editor-in-Chief* <editor@mycotaxon.com> and authors. All co-authors must correct and *proof-read* their files before submitting them to the *Nomenclature Editor*.

2—Nomenclatural review: Authors email all **error-free** text & illustration files to the *Nomenclature Editor* <PennycookS@LandcareResearch.co.nz>. Place **first author surname** + **genus** + 'Mycotaxon' on the subject line, and (required) attach a completed submission form. The Nomenclature Editor will (i) immediately assign the accession number and (ii) after a few weeks return his notes and suggested revisions to the author(s) and *Editor-in-Chief*.

3—Final submission: All coauthors thoroughly revise and proof-read files to prepare error-free text and images ready for immediate publication. Poorly formatted copy will be rejected or returned for revision. E-mail the final manuscript to the *Editor-in-Chief* <editor@mycotaxon.com>, adding the **accession number** to the message and **all** files, which include a **(i)** revised 2020 submission form, all **(ii)** text files and **(iii)** jpg images, and **(iv)** FN, IF, or MB identifier verifications for each new name or typification. The *Editor-in-Chief* acknowledges submissions within two weeks of final submission but requests authors to wait at least 14 days before sending a follow-up query (without attachments).

4—Final editorial review & publication: The *Editor-in-Chief* conducts a final grammatical and scientific review and returns her editorial revisions to all expert reviewers and coauthors for final author approval. Author-approved files are placed in the publication queue.

The PDF proof and bibliographic & nomenclatural index entries are sent to all coauthors for final inspection. After PDF processing, the *Editor-in-Chief* corrects only PDF editorial/conversion and index entry errors; corrections of all other errors are listed in the Errata of a subsequent issue for no charge. Authors will pay fees for mycobiota uploads, optional open access, and correction of major author errors to the *Business Manager* <subscriptions@mycotaxon.com> at this time.

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Two new genera of gymnopoid/marasmioid euagarics

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Abstract—Two new genera, *Paramycetinis* and *Pseudomarasmius*, are placed phylogenetically within the /omphalotaceae among genera allied with *Gymnopus*. *Paramycetinis* comprises two Antipodal taxa related to *Mycetinis*. Both *Paramycetinis* species are characterized by luxuriant rhizomorphs, with basidiomata arising occasionally as side branches but also separately from rhizomorphs. *Pseudomarasmius* accommodates four new species plus four others previously placed in *Marasmius*. *Pseudomarasmius* encompasses significant basidiomatal variation, but nrLSU- and ITS-based phylogenies support its taxa in a monophyletic clade that occupies a position related to some *Rhodocollybia*. All *Pseudomarasmius* and *Paramycetinis* species are described (or redescribed) and illustrated. Both genera exhibit characters also found in other superficially similar lineages, making non-molecular based diagnoses of genera in the /gymnopus/marasmiellus clades difficult.

Key words— biogeography, clamp connections, morphological taxonomy

Introduction

For the last few decades, numerous, small, "white-spored" saprotrophic mushrooms have undergone a comprehensive reclassification. Especially edifying has been the introduction of molecule-based phylogenetic analyses at about the turn of the 21st century. New taxa have been identified at several nomenclatural ranks, from infraspecific (Aldrovandi & al. 2015; Petersen & Hughes 2016, 2017a,b) to class (Moncalvo & al. 2002, Matheny & al. 2006, Dentinger & al. 2016). In many cases, detailed morphological descriptions have accompanied molecular analyses (or the reverse), but "morphological taxa" are still being proposed without phylogenetic placement (Petersen &

Hughes 2016a, 2017; Retnowati 2018) when materials are too old or degraded to produce molecular data or the appropriate instrumentation is unavailable.

Desjardin (1989) summarized the classification and publication history of *Marasmius* and its segregation from *Gymnopus* (sensu Persoon 1801) or *Collybia* (sensu Fries 1821). The taxonomic history of *Gymnopus* (as *Collybia*) was outlined by Halling (1983). Subsequently, Antonín & al. (1997) discussed infrageneric taxonomy within *Marasmius* and *Gymnopus* (as *Collybia*), and Hughes & al. (2001) segregated *Gymnopus* (*G. fusipes* typus generis) from *Collybia* s.s. (*C. tuberosa* typus generis).

Owings & Desjardin (1997) apparently conducted the first research into the collybioid/marasmioid complexes using DNA sequences based on a more expanded thesis (Owings 1997; nrITS-based). Their work revealed that marasmioid fungi were not monophyletic but segregated into three lineages: present-day *Physalacriaceae*, *Omphalotaceae*, and *Marasmiaceae*. Moncalvo & al. (2000, 2002; LSU-based) essentially inferred the same. Mata & al. (2004; ITS- & LSU-based) showed that *Marasmiellus juniperinus* (typus generis) belonged in the omphalotoid complex, Wilson & Desjardin (2005) tied the morphological fragmentation of *Marasmius* to an nrLSU-based phylogeny and refined phylogenetic relationships of a wider array of organisms, and Mata & al. (2007; ITS-based) offered a more comprehensive phylogeny of /omphalotaceae, with emphasis on *Gymnopus*. The nomenclatural consequence of these works was circumscription of two major clades/families, *Marasmiaceae* and *Omphalotaceae*. A further consequence was more detailed fragmentation within these groups (Petersen & Hughes 2016a, 2017), in which *Gymnopus* as summarized by Mata & al. (2007) is clearly para- to polyphyletic with several related genera (*Rhodocollybia*, *Lentinula*, *Mycetinis*, *Connopus*) interspersed and *Gymnopanella* (Sandoval-Leiva & al. 2016) also associated. Three genera (*Lentinula*, *Rhodocollybia*, *Mycetinis*) are well-populated while two (*Connopus, Gymnopanella*) currently appear monotypic. If the concepts of Wilson & Desjardin (2005) are advanced to the present day, two large and complex clades contain traditional gymnopoid/marasmioid taxa: /Gymnopus incorporates *Gymnopus* sects. *Levipedes*, *Striipedes,* and *Impudici*, the traditional *Micromphale* (including sect. *Perforantia*), *Caripia*, and *Marasmius* sect. *Androsacei;* /Marasmiellus (including *M. juniperinus*, typus generis) includes *Gymnopus* sect. *Vestipedes* as well as *Marasmius* (*Marasmiellus*) *ramealis*, the type of *Collybiopsis* (J. Schröt.) Earle (Hughes & Petersen, ined.). /Marasmiellus) would appear to be a candidate for fractionation.

Oliveira & al. (2019) recognized their clade I (called "*Gymnopanella*") based on the taxon described by Sandoval-Leiva & al. (2016) and which included two provisional names that had appeared in phylogenies by Petersen & Hughes (2016). We regard those two provisional names as belonging in a separate generic unit, here proposed as *Paramycetinis*, based on its placement as sister to *Mycetinis*.

The intention of this paper is to propose two new genera, one comprising two new Antipodal species and the other accommodating several species. Figure 1 shows the relative placement of the new genera based on nrLSU-sequence resolution.

Materials & methods

Abbreviations: Pa = *Paramycetinis*; Ps = *Pseudomarasmius*; M = *Marasmius*; Ma = *Marasmiellus*; Mi = *Micromphale*; My = *Mycetinis*. Colors cited alphanumerically are from Kornerup & Wanscher (1967) or Munsell (1961), in quotation marks from Ridgway (1912), and special reference to Maerz & Paul (1950); BF = bright field microscopy; PhC = phase contrast microscopy (see also Petersen & Hughes 2017); TFB = Tennessee field-book number, assigned to fresh collections. In order to track information for collections from TENN, numbers are the last five digits of the fungal herbarium accession number (in MyCoPortal as TENN-F-0xxxxx); GSM (also GSMNP) = Great Smoky Mountains National Park, Tennessee/North Carolina. Percent similarity values within and between clades are given on the right.

Culture media reported to encourage rhizomorph production followed directions by Farnet & al. (1999). Two different whole wheat flours ("whole wheat flour" and "stone-ground whole wheat flour," both obtained locally) produced no difference in rhizomorph occurrence, number, or vigor. The term "textura" to describe the intricate crust formed by many marasmioid, mycetinoid, marasmielloid, and gymnopoid isolates in culture has been borrowed from Korf (1973), who used it to describe the excipular layer of apothecia.

Metrics of microstructures were calculated using a phase-contrast Olympus BX60 microscope fitted with phase contrast imagery and microphotographs were produced using an Olympus Qc color camera. Microscope mounts were usually in 3% KOH solution or Melzer's reagent.

Molecular methods for DNA extractions, PCR and Sanger sequencing of the nuclear ribosomal ITS and LSU regions follow Aldrovandi & al. (2015). PhyML phylogenetic analyses were performed in Geneious 11.0.3 (2017). Sequences have been deposited in GenBank (Table 1). Specimen data are available in MyCoPortal (2018). Nexis files containing nrLSU sequences and alignments were deposited in the Dryad Data Repository https://doi.org/10.5061/dryad.4081h). ITS sequence %-similarity is the average of all paired sequences computed by Geneious 11.0.3 (2017) as "percent identity".

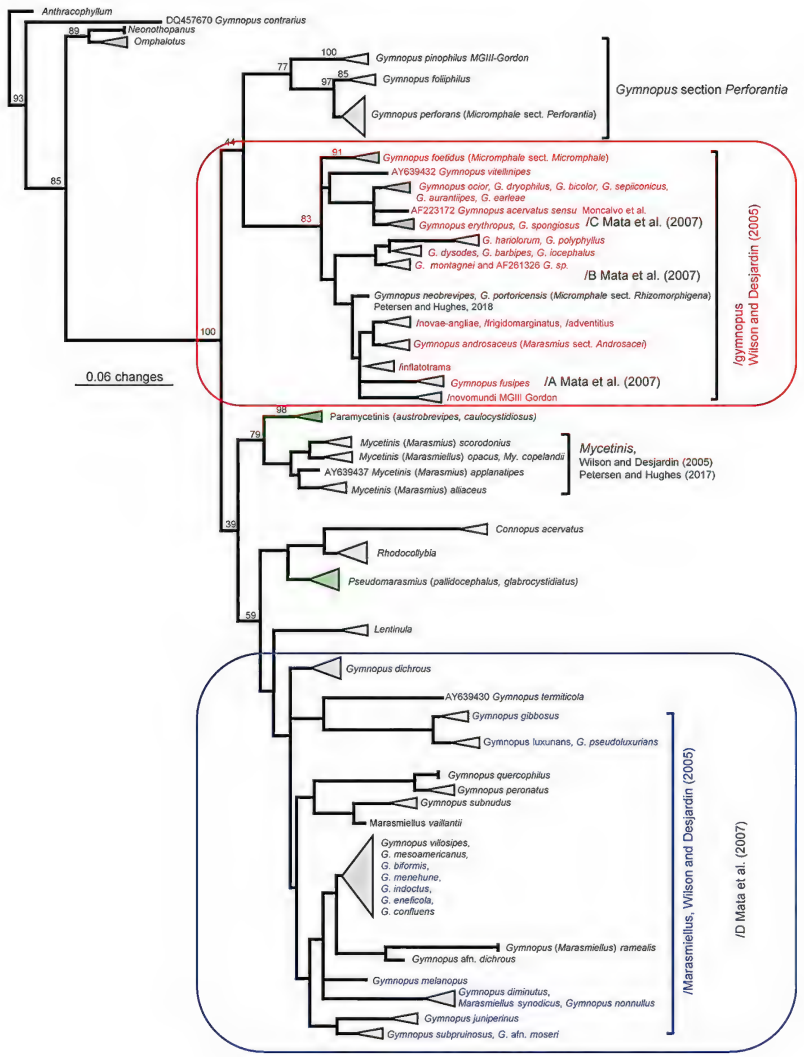

FIG. 1. PhyML analysis of 191 nrLSU sequences within the *Omphalotaceae* using 100 bootstrap replicates. Clades were collapsed to better show broad relationships. Species names in blue represent /marasmiellus (Wilson & Desjardin 2005). Species names bordered in red represent /gymnopus (Wilson & Desjardin 2005). The major clades reported in Mata & al. (2007) are bordered in blue. The genera *Paramycetinis* and *Pseudomarasmius* are in green.

TABLE 1. Collections used in phylogenetic analyses

NAME	GENBANK #	HERBARIUM #	FIELD #	LOCALITY
[FIG. 2—*Gymnopus, Paramycetinis, Mycetinis*]				
Gymnopus perforans	KY026675	TENN-F-61587	TFB13119	Canada, Quebec
	KY026719	TENN-F-69059	TFB14395	Canada, New Brunswick
G. foliiphilus	KY026703	TENN-F-68145	TFB14291	USA, Mississippi
G. sequoiae	KY026741	TENN-F-69325	TFB14620	USA, California
Paramycetinis austrobrevipes	KY026622	TENN-F-50135	TFB4033	Australia
	KY026637	TENN-F-53149	TFB3591	Australia
	KY026638	TENN-F-53181	TFB3585	Australia
P. caulocystidiatus	KY026642	TENN-F-53683	TFB7572	New Zealand
	KY026643	TENN-F-53721	TFB7588	New Zealand
	KY026644	TENN-F-53725	TFB7589	New Zealand
	KY026645	TENN-F-54050	TFB7148	New Zealand
Mycetinis alliaceus	AY635776	TENN-F-55620	TFB8960	Russia
	DQ450004	TENN-F-55555	TFB8935	Russia
	KY696752	TENN-F-55630	TFB8970	Russia
	KY696765	TENN-F-67899	TFB14149	Germany
	KY696766	TENN-F-67911	TFB14161	Germany
	KY696770	TENN-F-69243	TFB14548	Slovakia
	KY696771	TENN-F-69244	TFB14549	Slovakia
M. applanatipes	KY696775	SFSU DED6628	—	USA, California
M. copelandii	KY696750	TENN-F-55408	TFB8084h1	USA, California
	KY696751	TENN-F-55408	TFB8084h2	USA, California
M. kallioneus	KX958397	GB-0150513	—	Norway
M. opacus	KY696758	TENN-F-60016	TFB11787	USA, Tennessee, GSMNP
	KY696767	TENN-F-69190	TFB14499	Mississippi
	KY696768	TENN-F-69200	TFB11490h1	Mississippi
	KY696769	TENN-F-69200	TFB11490h2	Mississippi
M. querceus	KY696785	UPS F740422	—	Sweden
M. salalis	KX752265	DAOM175251	—	Canada, BC, Vancouver Isl.
M. scorodonius	DQ450006	TENN-F-50346	TFB4749	Switzerland

Name	GenBank #	Herbarium #	Field #	Locality
	KY696725	TENN-F-50343	TFB4746	Switzerland
	KY696726	TENN-F-50352	TFB4755	Switzerland
	KY696727	TENN-F-50369	TFB4772	Switzerland
	KY696728	TENN-F-50377	TFB4780	Switzerland
	KY696729	TENN-F-50447	TFB4372	Mexico
	KY696730	TENN-F-50515	TFB3778	Sweden
	KY696731	TENN-F-50522	TFB3785	Sweden
	KY696732	TENN-F-50533	TFB3796	Sweden
	KY696733	TENN-F-50689	TFB3701	USA, North Carolina
	KY696734	TENN-F-50696	TFB3708	USA, TN GSMNP
	KY696735	TENN-F-50763	TFB3644	USA, TN GSMNP
	KY696736	TENN-F-50809	TFB3690H1	USA, TN GSMNP
	KY696737	TENN-F-50809	TFB3690H2	USA, TN GSMNP
	KY696738	TENN-F-51233	TFB4915	USA, North Carolina
	KY696739	TENN-F-51442	TFB5031	Canada, Nova Scotia
	KY696740	TENN-F-53465	TFB5014	Canada, Nova Scotia
	KY696741	TENN-F-53466	TFB4969	USA, New York
	KY696742	TENN-F-53467	TFB5025	Canada, Nova Scotia
	KY696743	TENN-F-53468	TFB5038	Canada, Nova Scotia
	KY696744	TENN-F-53469	TFB4989	USA, Maine
	KY696745	TENN-F-53470	TFB5046	USA, North Carolina
	KY696746	TENN-F-53471	TFB4939	USA, New York
	KY696747	TENN-F-53472	TFB5067	USA, North Carolina
	KY696748	TENN-F-53474	TFB5005	USA, Maine
	KY696749	TENN-F-53568	TFB7261	Sweden
	KY696753	TENN-F-57663	TFB2782	USA, Georgia
	KY696754	TENN-F-58260	TFB10400	Russia, Western
	KY696757	TENN-F-59615	TFB11652	Russia
	KY696786	WTU19061H1	—	USA, Washington
	KY696787	WTU19061H2	—	USA, Washington

Name	GenBank #	Herbarium #	Field #	Locality
[Fig. 15—*Gymnopus, Marasmius, Pseudomarasmius,* cf. *Rhodocollybia,* etc.]				
Gymnopus glabrocystidiatus (T)	NR152899	BRNM718676	—	Korea
	KF251072	KFRI1935	—	Korea
Marasmius sp.	KR673444	KA12-0382	—	South Korea
Pseudomarasmius quercophiloides	MK268235	TENN-F-49177	TFB3162	China, Yunnan
Ps. efibulatus	MK268234	TENN-F-56187	TFB7070	New Zealand, South Island
	MK268236	JAC10695	—	New Zealand
Ps. patagonianus	KY352649	TENN-F-54424	TFB7364	Chile
Ps. nidus-avis	KY026646	TENN-F-54912	TFB9087	USA, Louisiana
	KY026723	TENN-F-69189	TFB14498	USA, Mississippi
	KY026732	TENN-F-69310	TFB14607	USA, Alabama
	KY026733	DPL11763	—	USA, Texas
	KY026753	Rhizomorph culture	TFB14606	USA, Mississippi
	MK020094	—	MES883	USA, Florida
	MK268237	FLAS-F-62667	MES1477	USA, Florida
	MK268238	FLAS-F-62668	MES3139	USA, Florida
	MH016872	FLAS-F-60891	—	USA, Florida
Ps. pallidocephalus	KY026635	TENN-F-52401	5610 culture	USA, Idaho
	FJ596762	TENN-F-59896	TFB11778h2	USA, TN GSMNP
	FJ596763	TENN-F-59896	TFB11778h1	USA, TN GSMNP
	KY026636	TENN-F-52427	TFB5698	USA, Washington
	KY026684	TENN-F-65829	TFB13933h1	USA, New York
	KY026685	TENN-F-65829	TFB13933h2	USA, New York
	KY026691	TENN-F-66344	SAT11-179-05	USA, TN GSMNP
	KY026746	no specimen	5015 culture	Canada, Nova Scotia
Rhodocollybia	FJ475743	soil sample	—	Sweden
aff.	KC966049	soil sample	—	Alaska
R. sp.	AY313287	TENN-F-58798	TFB10712	Greenland
Tricholomataceae	LCO14889	no specimen	8PBL11	Japan, Nagano
—	JN890248	soil sample	—	Guyana
—	JN890219	soil sample	—	Guyana
—	JN890249	soil sample	—	Guyana

Paramycetinis

The nrLSU sequence analysis places *Paramycetinis* within a moderately supported clade that includes *Mycetinis* (Fig. 1). A PhyML analysis of *Mycetinis* and *Paramycetinis* nrITS sequences (Fig. 2) places *Paramycetinis* as sister to a clade containing several *Mycetinis* species. The average base pair identity between *Paramycetinis* and *Mycetinis* is 91.72%.

Only sparse literature on marasmioid fungi from Australia (Fuhrer 1985), South Australia (Cleland 1934, Grgurinovic 1997), and Tasmania (Eygelsheim 1981, Fuhrer & Robinson 1972) preceded introduction of molecular phylogenetic analyses. Those publications grouped collections of small marasmioid basidiomata as "*Marasmius crinis-equi*" or "horse-hair fungi" according to the presence of obvious rhizomorphs when, in fact, several discrete taxa qualify under this superficial diagnosis and await formal proposals. More recently, Desjardin & Horak (1997) revisited earlier work by Stevenson (1964) and Horak (Horak 1971a,b) to revise numerous marasmioid fungi from Papua New Guinea, New Caledonia, and New Zealand, and Desjardin & al. (2000) summarized *Marasmius* for parts of Indonesia.

Even less literature dealt with *Micromphale* (here understood as *Gymnopus* sect. *Micromphale*) on the Australia/New Zealand landmasses [but see Cooper & Leonard (2013) on micromphalioid *Gymnopus* taxa]. To our knowledge, only Grgurinovic (1997) has dealt with species of sect. *Perforantia* (*Agaricus perforans*, typus sectionis); she placed *Micromphale australiense, M. rugosum*, and *M. villosipes* (all from South Australia) in *Micromphale* based solely on morphological characters.

Owings & Desjardin (1997) first identified three infrageneric phylogenetic clusters accommodating *Marasmius* taxa; subsequent phylogenetic studies refined this early finding. In nrLSU sequence analyses of marasmioid and gymnopoid fungi, Wilson & Desjardin (2005) identified a clade including taxa previously segregated into the morphogenus *Mycetinis* Earle (1909; *Agaricus alliaceus,* typus generis). This clade was also resolved by Mata & al. (2004, 2007) but not nomenclaturally separated from *Gymnopus*, which they accepted in a very broad sense. Petersen & Hughes (2016), who also showed a /mycetinis clade in their overall nrLSU phylogeny of *Gymnopus* and associated genera, found that /mycetinis comprised three subclades, of which the sister subclade to *Mycetinis* contained sequences of two taxa known only from Tasmania and New Zealand. This small subclade, sister to /mycetinis, is taken up here as *Paramycetinis.*

/Mycetinis is presently accepted as inclusive of traditionally disparate morphological taxa. From its re-disclosure by Wilson & Desjardin (2005; LSU-based), *My. alliaceus* and *My. scorodonius* were joined by *Marasmiellus opacus*, so Wilson & Desjardin (2005) furnished a discussion of morphological characters justifying inclusion of *Ma. opacus* in /mycetinis and proposed appropriate transfers. Likewise, Mata & al. (2007; ITS-based) placed *Ma. candidus* in the same clade although Wilson & Desjardin (2005) had placed it in /tetrapyrgos, an adjoining clade. At genus rank, *Mycetinis* has been accepted by Antonín & Noordeloos (2010) and lately surveyed by Petersen & Hughes (2017b). One ITS-based PhyML phylogeny (Fig. 2) shows the relationship of *Paramycetinis* to *Mycetinis*.

Oliveira & al. (2019) recognized a small clade (their clade I) called "*Gymnopanella*," based on the taxon described by Sandoval-Leiva & al. (2016). Their clade I included two provisional names that appeared in phylogenies by Petersen & Hughes (2016). We consider the two provisional names to belong in a separate generic unit, here proposed as *Paramycetinis*.

Paramycetinis R.H. Petersen, **gen. nov.**

IF 555792

Basidiomata diminutive, associated with dominant black rhizomorphs; a monophyletic clade.

Type species: *Paramycetinis austrobrevipes* R.H. Petersen

Etymology: reflecting the sister phylogenetic relationship to *Mycetinis*.

Basidiomata combining characters of *Gymnopus* sect. *Micromphale* subsect. *Perforantia*, *Gymnopus* sect. *Androsacei,* and *Marasmius* sect. *Sicci*, minute to small, arising as rhizomorph branches or separate from rhizomorphs. Pileus small (3–15 mm broad), some shade of brown or vinaceous brown, sometimes sulcate-striate, smooth or minutely pruinose; pileus trama thin, pliant. Lamellae adnexed to adnate, sometimes attached to an adherent pseudocollarium, close to subdistant, from ridge-like to well-developed, usually with lamellulae in 1–2 ranks, off-white to dull vinaceous gray. Stipe capillary, ≤3 mm broad, terete, more or less equal, solid to stuffed, glabrous-shining to minutely velutinous, brown to brown-black, especially downward, insititious (when not a rhizomorph branch). Rhizomorphs common, ranging from very slender to stout, sometimes dominant and forming loose nets, usually black. Pileipellis commonly involved in slime as a matrix and/or as gelatinizing hyphal walls, usually including diverticulate hyphae and broom cell-like hyphal termini. Pleurocystidia ubiquitous, narrowly to broadly fusiform; contents

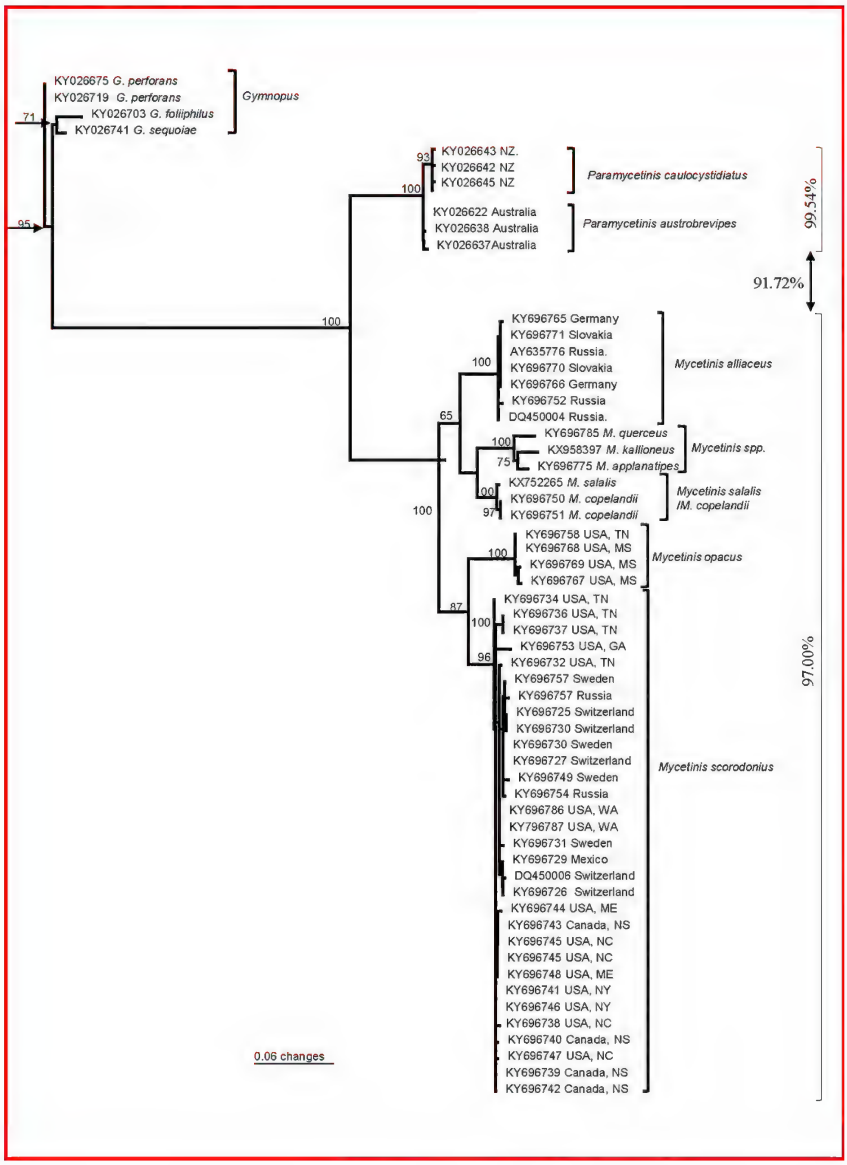

Fig. 2. Maximum likelihood analysis of combined ribosomal RNA ITS and LSU sequences. Bootstrap values are given to the left of the supported node. Numbers are GenBank accession numbers (See Table 1). For collections from the United States and Canada, the state or province postal code is given. Percent similarity values within and between clades are given on the right.

more or less homogeneous, occasionally vaguely partitioned. Basidia clavate, 4-sterigmate. Basidiospores thin-walled, smooth, inamyloid, white or off-white in deposits. Cheilocystidia present, arbuscular (stalked, branched) or broadly clavate, with or without diverticula. Stipe medullary hyphae strictly parallel, usually involved in a slime matrix. Caulocystidia present or absent, when present gregarious to scattered (not a dense turf), setoid. Clamp connections present. Molecular analysis resolving a monophyletic clade associated with *Mycetinis*.

Key to taxa of *Paramycetinis*

1. Rhizomorphs stout (>1 mm diam), forming loose nets; basidiomata arising from or separate from rhizomorphs; cheilocystidia clavate with clusters of apical setulae (Tasmania) ..... *Pa. austrobrevipes*
1. Rhizomorphs slender (<1 mm diam), extensive; basidiomata arising separate from rhizomorphs; cheilocystidia clavate, without diverticula; fruiting on dead leaves and twigs of *Nothofagus* (New Zealand)..... *Pa. caulocystidiatus*

Paramycetinis austrobrevipes R.H. Petersen, **sp. nov.** Figs 3–8

IF 555793

Differs from *Paramycetinis caulocystidiatus* by its broader rhizomorphs that form loose nets, by its basidiomata that arise as rhizomorph branches and/or from woody substrate, and by its broom cell-like cheilocystidia.

Type: Australia, Tasmania, Gordon-Pedder National Heritage Area, Rainforest Nature Walk vicinity, 8.VI.1991, coll. RHP & KWH, TFB 4033 (**Holotype** TENN-F-050135).

Etymology: referring to micromorphological similarities to *Gymnopus neobrevipes*.

Basidiomata (Fig. 3) marasmioid, diminutive, arising as branches from rhizomorphs and/or directly from woody substrate. Pileus 2–12 mm broad, convex to shallowly conical, sometimes abruptly or broadly umbonate and even then abruptly umbilicate, deeply sulcate-striate to non-striate, matte, at high magnification (50×) telltale wispy white hairs can be seen in the sulcate depressions; disc (including umbo) 5F6 ("Prout's brown"), 6E3 ("hair brown"), 9D3 ("benzo brown"), 7C4 ("wood brown"), 6E4 ("fuscous"), 7C6 ("Mikado brown") to 9C3 ("cinnamon drab"); limb 6C5 ("sayal brown"), 6B5 ("cinnamon"), 17B2 ("light drab"), 7B2 ("tilleul buff"), to 9B2 ("vinaceous buff"), 8D5 ("army brown"), 9C3 ("cinnamon drab"), 9B3 ("light cinnamon drab") to 7C5 ("fawn color"); margin 6A3 ("pinkish buff") to 4A3 ("cartridge buff"). Lamellae adnexed, subdistant (total lamellae 20–24), about 1 mm broad, thickish, without anastomoses, 7B2 ("tilleul buff"), 9B2 ("vinaceous buff"), 6B4 ("cinnamon buff") to 6A3 ("pinkish buff"), not marginate; dried

lamellar trama dark brown and glassy, as though gelatinized. Stipe 18–85 × 0.8–1.2 mm, terete, stuffed (not hollow), appearing glabrous–shining but minutely pruinose at least upward and downward (35×), black to abruptly 6C5 ("sayal brown"), 6B3 ("cinnamon buff") or mahogany at very apex (not concolorous with lamellae), downward totally black; medullary portion cloud gray, cortical layer thin, nearly black (40×); insertion non-insititious; vesture sparse, pallid, near 7B2 ("tilleul buff"). Rhizomorphs >1 mm broad, gradually tapering to 0.2–0.5 mm distally, terete or somewhat compressed, extensive to almost absent, often forming a rudimentary net. Odor negligible; taste negligible or weak of garlic; consistency tough then mealy.

Habitat & phenology: *Nothofagus* wood (and then densely gregarious) and twigs, at or near forest floor, *Arthrotaxis* dead branchlets; to this time, May–June.

Pileipellis constructed of the following: 1) slender hyphae 2–3.5 µm diam, thick-walled (wall <0.5 µm thick), sparsely encrusted (Fig. 4a) with ornamentation appearing as flakes adhered to outer hyphae wall; 2) slender hyphae 1.5–3 µm diam, firm-walled with slender, sometimes awl-shaped diverticula (Fig. 4b, 5a–d), obscurely clamped, forming a indiscrete layer in a mucoid matrix (i.e. significant debris including bacteria and collapsed spores, PhC); 3) slender, coralloid hyphal termini (Fig. 5e,f); 4) thicker hyphae 4–12 µm diam, refringent (PhC), infrequently branched, meandering to appear a bit like lattice, thick or gelatinized–walled (wall <2.5 µm thick), with outer profile smooth and clear but inner wall contour irregular, obscurely clamped; termini occasionally more or less erect as "pileal hairs." Pleurocystidia (Figs 6b, 7a–c) common, 26–33 × 5–9 µm, fusiform to mucronate, conspicuously clamped, usually with partitioned contents. Basidia 23–28 × 6–9 µm, clavate, 4-sterigmate (sterigmata <6 µm long, somewhat bowed, stout), obscurely clamped; contents homogeneous. Basidiospores (Fig. 6a) 6–9 × 3.5–4.5 (–5) µm (Q = 1.502.43; Q^m = 1.92; L^m = 7.47 µm), more or less pip-shaped but often tapered slightly proximally (that is, perhaps marasmioid), smooth, thin-walled, inamyloid; contents homogeneous. Cheilocystidia (Figs 6d, 7e–h) locally common to scattered among basidia, 17–32(–40) × 5–12 µm, clavate to ventricose-rostrate, obscurely clamped, thin-walled below, firm-walled above, surmounted by a corona of extremely complex, vermiform to slender-digitate, refringent (PhC) diverticula; diverticula <7 × 0.71 µm, gnarled, often branched. Stipe medullary hyphae hyaline, 2–5.5 µm diam, firm- to thick-walled, seldom but conspicuously clamped; cortical

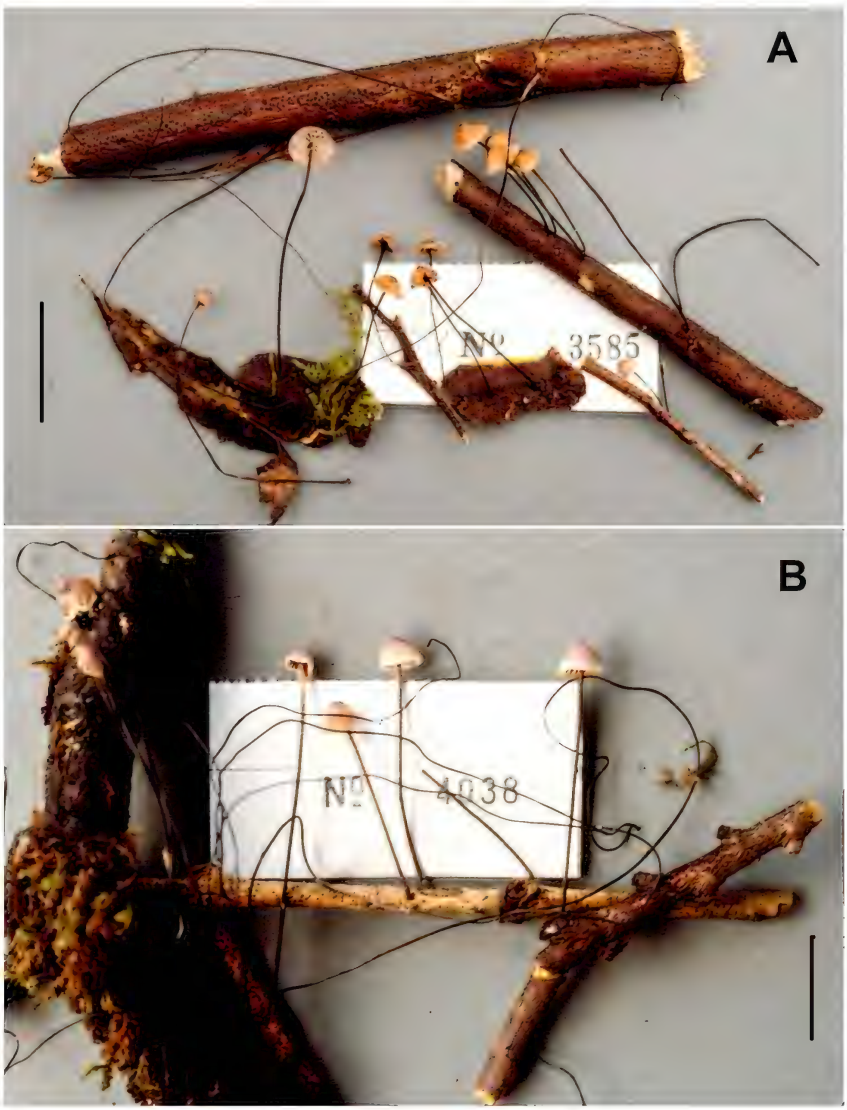

Fig. 3. *Paramycetinis austrobrevipes.*
Habit. A. (TENN 53181). B. (TENN-F- 050212). Scale bars: 20 mm.

hyphae adherent, 3–7 µm diam, yellow singly, dark ochraceous brown and refringent in mass (PhC), involved in a thin film of mucus, with side branches ranging from simple lobes to caulocystidia. Caulocystidia (Fig. 8)

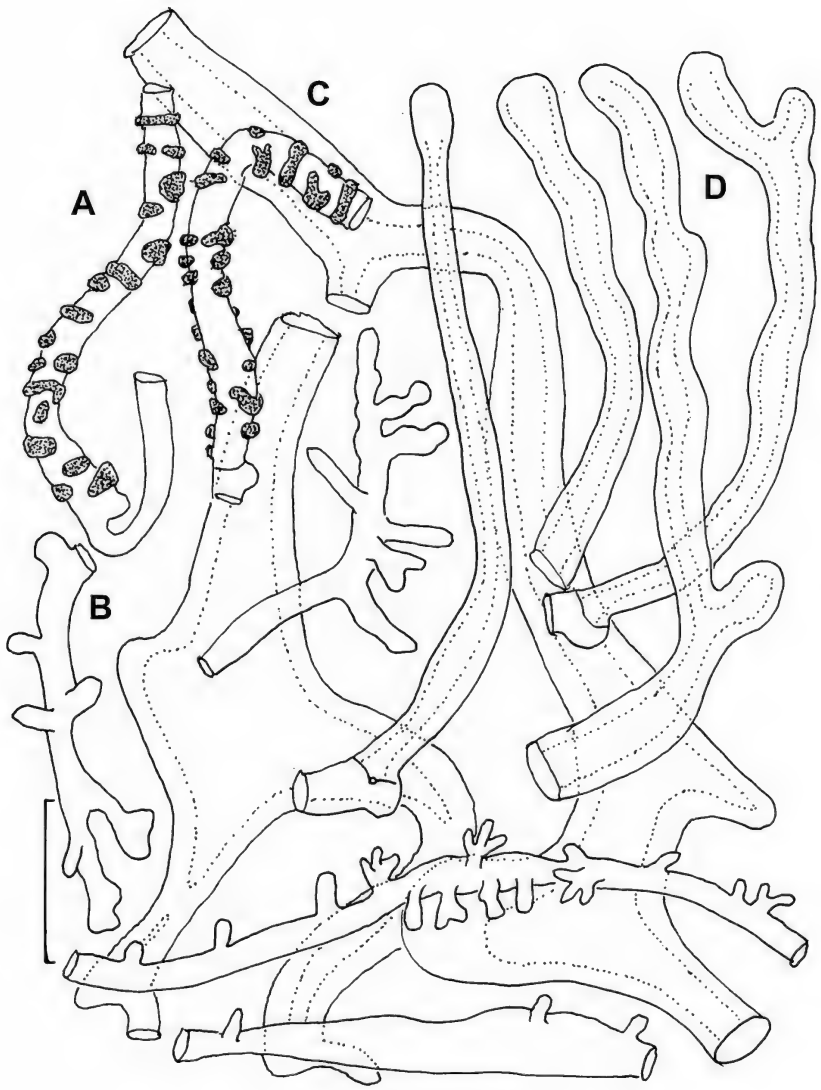

FIG. 4. *Paramycetinis austrobrevipes*. Structures of pileipellis. A. Encrusted hyphae (TENN 50119). B. Diverticulate hyphae (TENN-F-050135). C. Thick-walled lattice hyphae (TENN-F-050135). D. Pileal hairs (TENN-F-050119. Scale bars: 20 μm.

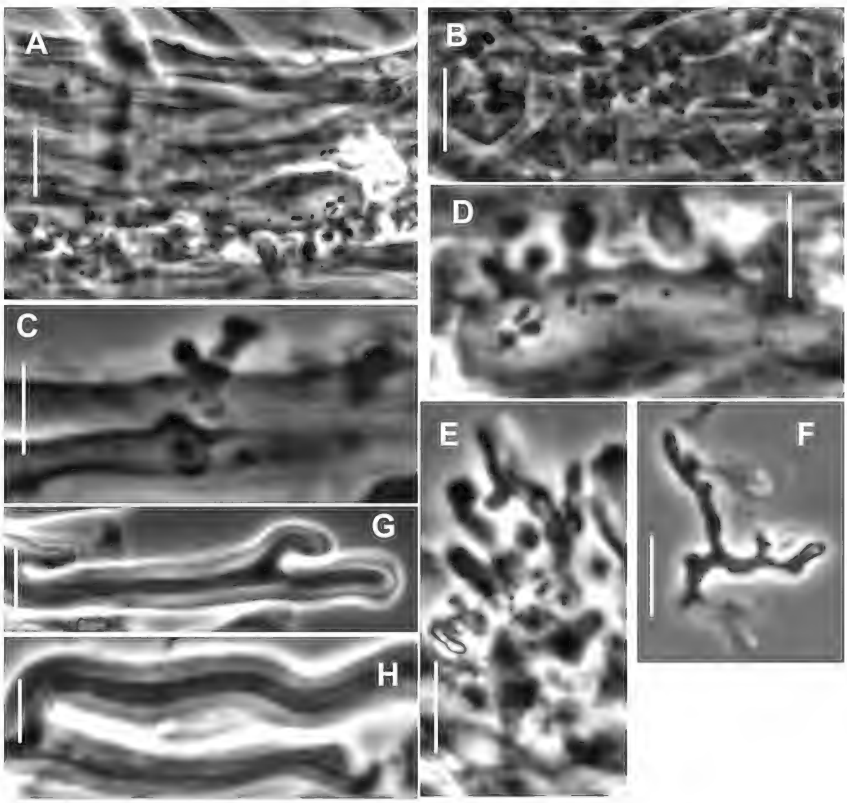

FIG. 5. *Paramycetinis austrobrevipes* (TENN-F-050135). Pileipellis elements. A. Layer of diverticulate hyphae as embedded within pileipellis. B. Layer of diverticulate hyphae. C,D. Individual diverticulate hyphae. E, F. Broom cell-like hyphal termini. G,H. Hyphae with gelatinized walls. Scale bars: 10 µm.

scattered, <105 × 46 µm (at widest point, narrowing to 3–3.5 µm diam at base, 2–3 µm diam at apex), gregarious but more or less evenly distributed, usually single, rarely in pairs, as side branches of stipe surface hyphae, apparently near the terminus of such hyphae (and therefore appearing as though from an asymmetrical origin, yellow and refringent (PhC), so refringent that wall thickness is hardly discernible (when wall seems to be discernible, 1–1.5 µm thick), narrowly rounded apically and apparently without adherent debris, dextrinoid (Melzer's reagent + PhC) or brown (Melzer's reagent + BF), not internally septate.

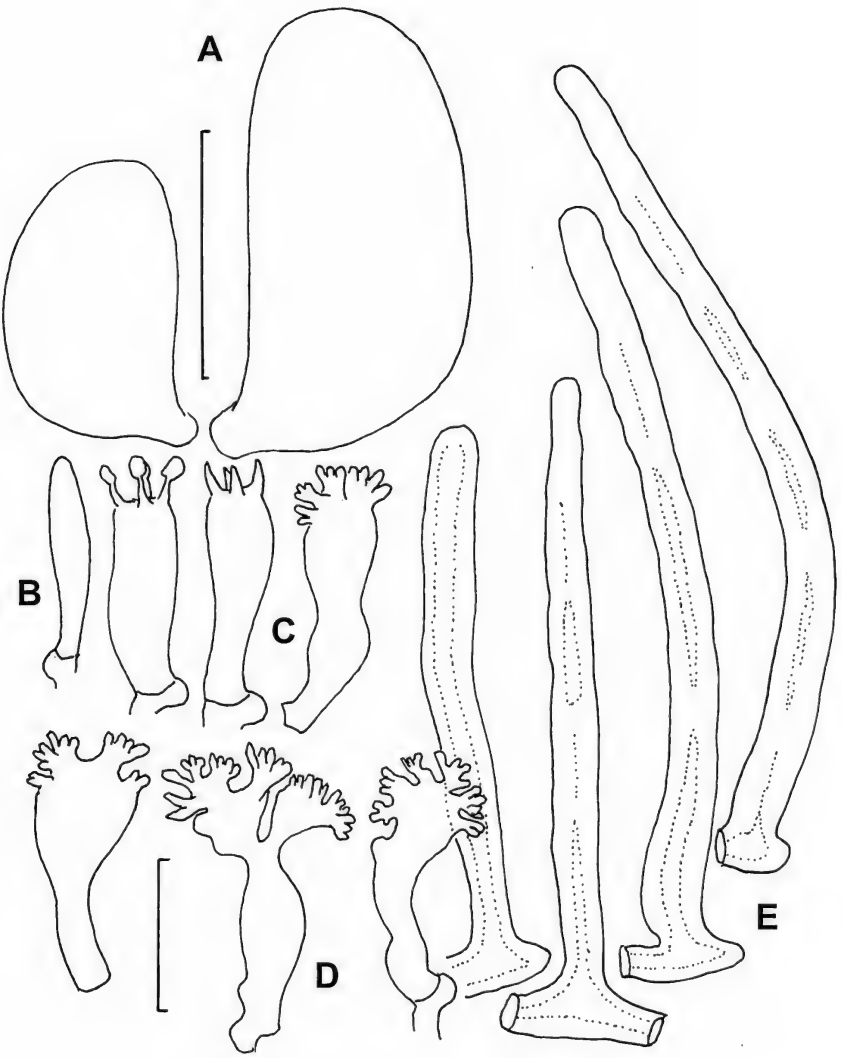

Fig. 6. *Paramycetinis austrobrevipes* (TENN-F-050135).
A. Basidiospores. B. Pleurocystidium. C. Basidia. D. Cheilocystidia. E. Caulocystidia.
Scale bars: A = 5 µm; B–D = 20 µm.

Commentary: Pileus shape in *Pa. austrobrevipes* varies from convex with an abrupt, distinct umbo to a gradual and shallow umbo to no evidence of an

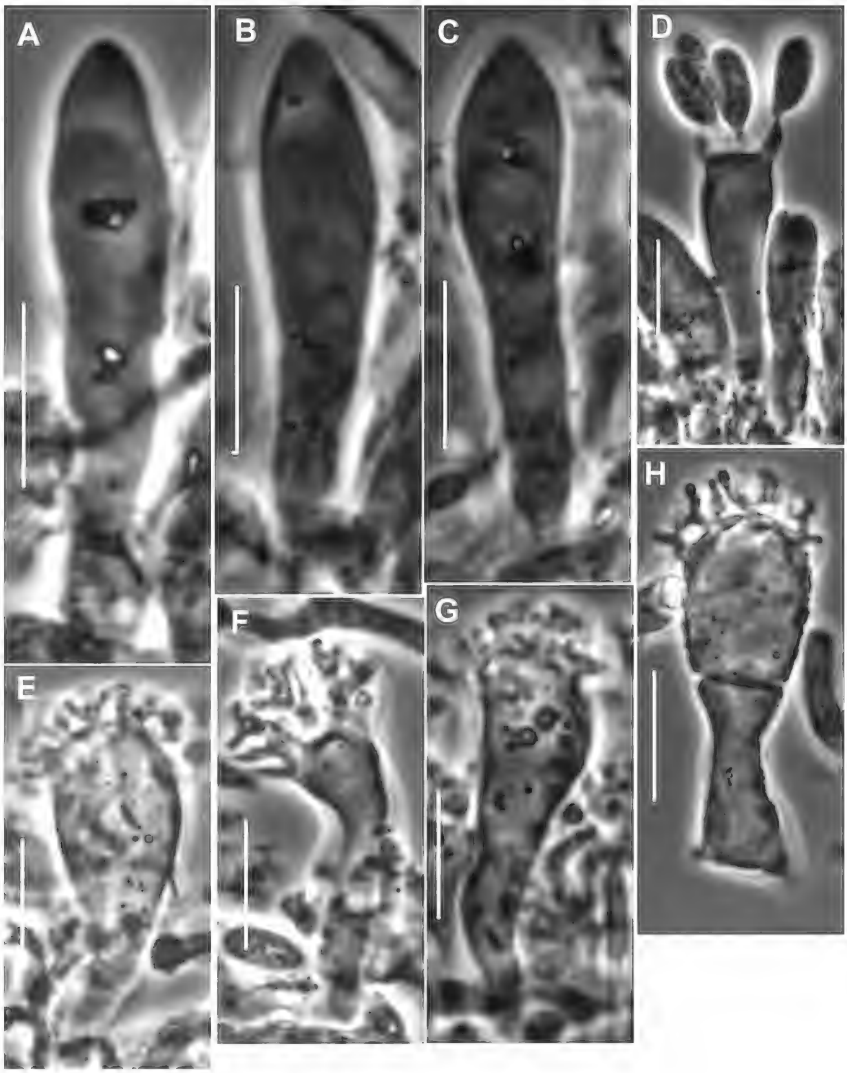

Fig. 7. *Paramycetinis austrobrevipes* (TENN-F-050135).
A–C. Pleurocystidia. D. Basidium. E–H. Cheilocystidia. Scale bars: 10 µm.

umbo. In all cases, the disc (with or without umbo) is significantly darker than the limb.

The pileus micromorphology of *Pa. austrobrevipes* approaches that of the North American *Marasmius brevipes* [≡ *Gymnopus neobrevipes* R.H. Petersen &

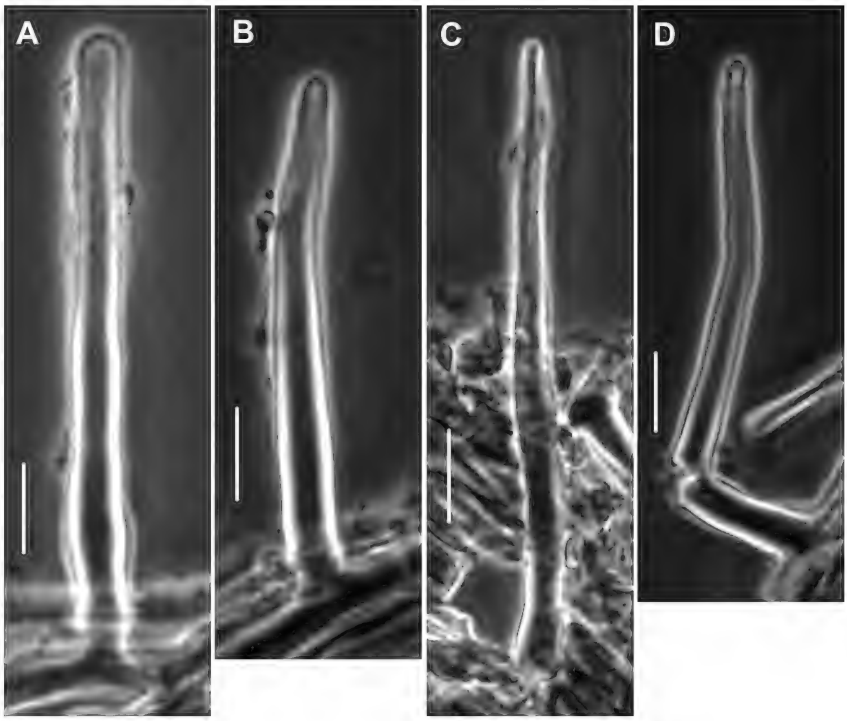

Fig. 8. *Paramycetinis austrobrevipes* (TENN-F-050135). Caulocystidia. Scale bars: 10 µm.

Hughes 2019)]. Basidiomata of both species arise on woody substrate (usually twigs with thin bark intact or occasionally as branches from an extensive rhizomorph net), but *G. neobrevipes* basidiomata are small and thumb tack-shaped while those of *Pa. austrobrevipes* are tall and mycenoid. Pileus colors are similar but also characteristic of several taxa in *Gymnopus* sect. *Androsacei*. Rhizomorphs and stipes are black, although stipe in *G. neobrevipes* is glabrous throughout its length. There is no record of a weak or latent taste of garlic for *G. neobrevipes*. Comparison of notes and drawings of *G. neobrevipes* specimens indicate that it also has a gelatinizing pileipellis, but with a more demonstrable "*ramealis*-structure." *Gymnopus neobrevipes* basidiomata also occur independently from rhizomorphs as well as branches from rhizomorphs, and its rhizomorphs are also thick and form an aerial network as well as on the substrate surface. Despite these similarities, molecular evidence shows *Pa. austrobrevipes* and *G. neobrevipes* to be only distantly related (see Fig. 1).

The surviving culture of TENN-F-053181 (TFB 3585) formed considerable aerial mycelium and what appears to be resupinate rhizomorphs against the side of the MEA-slanted storage test tube. This is different from other cultures of the same putative species but identical to a culture of TFB 3966, of which voucher basidiomata are no longer extant.

Collections of *Pa. austrobrevipes* may be mistaken in the field for *M. crinis-equi*. The latter can be distinguished in the field by collariate lamellae, significantly smaller basidiomata with short, curved stipes and typical hymeniform pileipellis and cheilocystidia. Grgurinovic (1997) cited collections of *M. crinis-equi* from New South Wales and South Australia, and Pegler (1977) furnished a much wider range for the species.

Close inspection of rhizomorph surfaces shows that when rhizomorphs branch, whether to produce a basidiome or a sterile branch, there is often a rupture of the parent rhizomorph cortex—splitting the cortex and revealing the medulla. This rupture is sparsely covered by a brown mycelium, which also covers the basal portion (<50 µm) of the new branch. Whether sterile or fertile, the new branch is also vestured with caulocystidia, which peter out in less than a millimeter distally, leaving the greater portion of the rhizomorph branch (or stipe) subglabrous.

On whole wheat flour agar (Farnett & al. 1999), cultures of *Pa. austrobrevipes* produced chiefly submerged mycelium, no textura intricata, and no rhizomorphs. TFB 3591 (TENN-F-053146) produced a minutely granular white mycelial mat with ill-defined margins.

Text and illustrations of *Paramycetinis* species were generously pre-reviewed by Australian and New Zealand mycologists in order to avoid nomenclatural duplication of any taxon already described. While no present-day match was suggested (but see below), five historical names under *Marasmius* were pointed out, as follows:

Marasmius eucalypti Berk., in Hooker, Fl. Tasman. 2: 249, 1859 ["1860"].

Pegler (1965: 331) examined the type specimen. While a basidioma is illustrated as arising as a side branch of a rhizomorph, pileipellis was described as "hymeniform, composed of diverticulate elements similar to the cheilocystidia." Thick-walled caulocystidia are described and illustrated. All of this indicates identification as a *Marasmius*, probably *M.* sect. *Sicci*.

Marasmius meloniformis Berk., in Hooker, Fl. Tasman. 2: 249, 1859 ["1860"].

Pegler's (1965: 339) study of the type specimen described surviving material in poor condition. The "long, setaceous stipes, which arise as branches from

creeping rhizomorphs" must resemble the habit of *Paramycetinis austrobrevipes*. Conversely, the following characters do not match: 1) pileus 1–2 mm broad, strongly plicate; 2) lamellae few; 3) epicutis hymeniform; 4) cheilocystidia broom cell-like. Pegler (1965) concluded: "The species clearly belongs in the genus *Marasmius*, sect. *Marasmius*."

Marasmius subsupinus Berk., in Hooker, Fl. Tasman. 2: 249, 1859 ["1860"].

From Berkeley's description the following is inferred: Basidiomata apparently conchate with a very short, curved stipe. Lamellae "so thick and rigid that this pretty species might almost be placed in *Lentinus*." "It varies in color from nearly white to rufous."

Marasmius emergens Cooke, Handb. Austral. Fungi: 88, 1892.

Protologue: "Very minute, white, suberumpent; pileus convex (1 mm broad); stem abbreviated, or sometimes elongated, curved, ascending; gills distant, few, white. On wood. Tasmania."

Marasmius subroseus Cooke & Massee, Grevillea 21: 37, 1892.

The protologue implies the following: basidiomata caespitose; no mention of rhizomorphs; "stem becoming a little reddish downwards and clad at the base with white pubescence;" gills distant. Unless proven otherwise, the organism can be accepted as a *Marasmius*.

In addition to these names, an undescribed Australian species is well-known under the informal name of *Marasmius* "angina." Online, numerous photos and one description (http://www.elfram.com/fungi/fungi_l/marspang_a.html; https://www.bushheritage.org.au/blog/fungi-and-citizen-science-in-the-liffey-valley) show an unmistakable resemblance to *Paramycetinis austrobrevipes*, except that the basidiomata are distinctly larger and no rhizomorphs appear in any photo. There is no reason (yet) to consider *Marasmius* "angina" as anything but a true *Marasmius*.

Additional specimens examined: **AUSTRALIA, Tasmania, Cradle Mountain National Park**, Waldheim Nature Track, 31.V.1991, coll. RHP & KWH, TFB 3977 (TENN-F-053232); **Geeveston**, Tahune Forest Preserve, 5.VI.1991, coll. RHP & KWH, TFB 4008 (TENN-F-050195); **Gordon-Pedder National Heritage Area**, Rainforest Nature walk vicinity, 8.VI.1991, coll. RHP & KWH, TFB 4038 (TENN-F-050212); **Hobart**, Mt. Wellington, gully at 400 m elev., 25.V.1991, coll. KWH, TFB 3591 (TENN-F-053146); coll. RHP & KWH, TFB 3585 (TENN-F-053181); **Lake Pedder National Heritage Area**, 26.V.1991, coll. RHP & KWH, TFB 3917 (TENN-F-050119); **Lake St. Clair National Park**, Mt. Rufous track, 29.V.1991, coll. RHP & KWH, TFB 3945 (TENN-F-050073); 8-10 kms north of Rosebery, slopes of Mt. Murchison, 30.V.1991, coll. RHP & KWH, TFB 3949 (TENN-F-051333); coll. RHP, TFB 3966 (TENN-F-053231).

FIG. 9. *Paramycetinis caulocystidiatus* (TENN-F-053721). Basidiomata and rhizomorphs on natural substrate.

Paramycetinis caulocystidiatus R.H. Petersen, **sp. nov.** FIGS 9–14

IF 555794

Differs from *Paramycetinis austrobrevipes* by its 1) pileipellis with evidence of slime matrix; 2) high stipe length to pileus breadth ratio; 3) fruiting habit on black beech; and 4) gregarious (but separate) setoid caulocystidia.

TYPE: New Zealand, North Island, Urewera National Park, track to Waipai Swamp, 35°45′13″S 177°09′17″E, 27.V.1994, coll. RHP, TFB 7148 (**Holotype** TENN-F-054050).

ETYMOLOGY: referring to caulocystidia of the vestured stipe.

BASIDIOMATA (FIG. 9) slender, of medium stature, marasmioid. PILEUS 2–8 (–20) mm broad, convex at first, later campanulate to applanate with depressed disc and margin remaining downturned, minutely tuberculate, translucent-striate to sulcate at margin, surface moist, hygrophanous, glabrous; central dot 8E6 ("Natal brown"), 6D6–6D5 ("snuff brown" near "olive brown"), 5D6–5D5 ("buckthorn brown"), "hazel brown," 6D8–6D4 ("buffy brown"), fading to 5C5–5C4 ("tawny olive"); limb and margin 7C4 ("wood brown") to 6C5 ("sayal

brown"). LAMELLAE adnexed, suppressed and ridge-like to subventricose, subdistant, <2 mm broad, thickish, total lamellae = 35–50(–75), through lamellae = 10–17 per pileus with 1–2 ranks of lamellulae between each through-lamella, not forked or interveined, 4A2 ("pale ochraceous buff"), 5A2 ("pale cinnamon pink"), 9B2 ("vinaceous buff"), to 5B8 pastel burnt orange to near 6B3 ("tilleul buff," not white); edge entire, rounded (not sharp), not fimbriate, not marginate. STIPE 30–40(–75) × 1.3–2 mm, terete, equal (stipe base often slightly swollen), not insititious; surface moist to dry, pruinose, uniformly vestured as a turf of perpendicular setoid caulocystidia, upward 7C4 ("wood brown") to 7D5 ("Rood's brown"), downward 7E6 ("auburn"), 7E6 ("VanDyke brown"), 7F5 ("blackish brown (1)") to black; "sterile stipes" often present, 20–32 × 1–2.5 mm, straight, stiff, vestured, without pileus, occasionally decapitated (FIG. 9) and then producing rhizomorph extension (black, slender, glabrous). RHIZOMORPHS <30 × 0.2–0.7 mm (at base), glabrous, gradually narrowing to flagelliform, mostly black, only slightly paler distally, when decapitated producing a rhizomorph or stipe (glabrous versus vestured) extension, but not producing pileate basidiomata from rhizomorphs. ODOR negligible; TASTE negligible.

HABITAT AND PHENOLOGY: On dead twigs, leaves and small branches of *Nothofagus solandri*; North Island, New Zealand; May–June.

PILEIPELLIS a repent layer of generally radially oriented hyphae embedded in a thin slime matrix, tightly packed, of the following types: 1) pileal hairs (FIG. 10) <100 × 3–5 µm, perhaps erect, produced as termini of repent hyphae (FIG. 11) finely encrusted, usually subtly capitulate; 2) repent hyphae 2–8(–13) µm diam, at surface usually of the wider type, firm-walled, coarsely encrusted in thick scabs; profile calluses ≤2 µm thick, sub-refringent (PhC); crust material often distributed with suggestion of striped or annular thickenings; 3) repent hyphae 5–10 µm diam with gelatinizing walls (wall ≤2.5 µm thick), variously encrusted; 4) subpellis hyphae usually thicker (6–14 µm diam), smooth or with very fine encrustation appearing gritty on the hyphal surface; clamp connections ubiquitous. PLEUROCYSTIDIA (FIG. 12) 24–32 × 6–9 µm, common, broadly fusiform, conspicuously clamped; contents homogeneous to distinctly partitioned. BASIDIA 25–30 × 7–11 µm, clavate, often sub-urniform, 4-sterigmate, clamped; effete basidia (and pleurocystidia) do not disappear but leave residual lateral walls and shriveled sterigmata ("husking"). BASIDIOSPORES (5–)6.5–8(–9) × 3.5–4(–4.5) µm (Q = 1.43–2.43; Q^m = 1.92; L^m = 7.41 µm), ellipsoid, somewhat flattened adaxially, smooth, thin-walled, inamyloid. CHEILOCYSTIDIA (FIG. 13) hardly distinguishable from basidia,

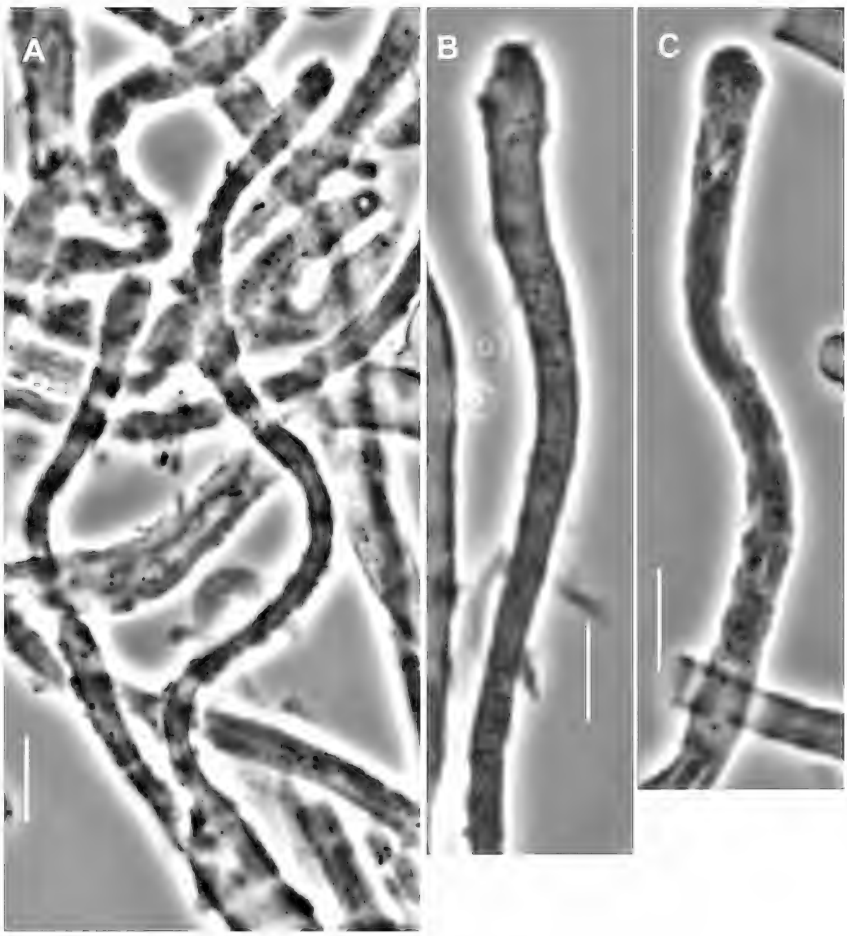

Fig. 10. *Paramycetinis caulocystidiatus* (TENN-F-054050).
Pileal hairs. A. Origin of two pileal hairs. B,C. Individual pileal hairs. Scale bars: 10 μm.

29–35(–42) × 6–13 μm, broadly truncate-clavate, hardly lobed apically, obscurely clamped. Stipe medullary hyphae 3–9 μm diam, strictly parallel, adherent with minimal slime matrix, thin-walled inward, with gelatinizing walls (<2.5 μm thick) near cortex, obscurely clamped, hyaline, inamyloid inward, increasingly dextrinoid toward stipe surface (to moderately so in Melzer's reagent + BF). Stipe cortical hyphae strictly parallel, probably coherent and perhaps with thin slime layer, coarsely encrusted, thick-walled, yellow-brown

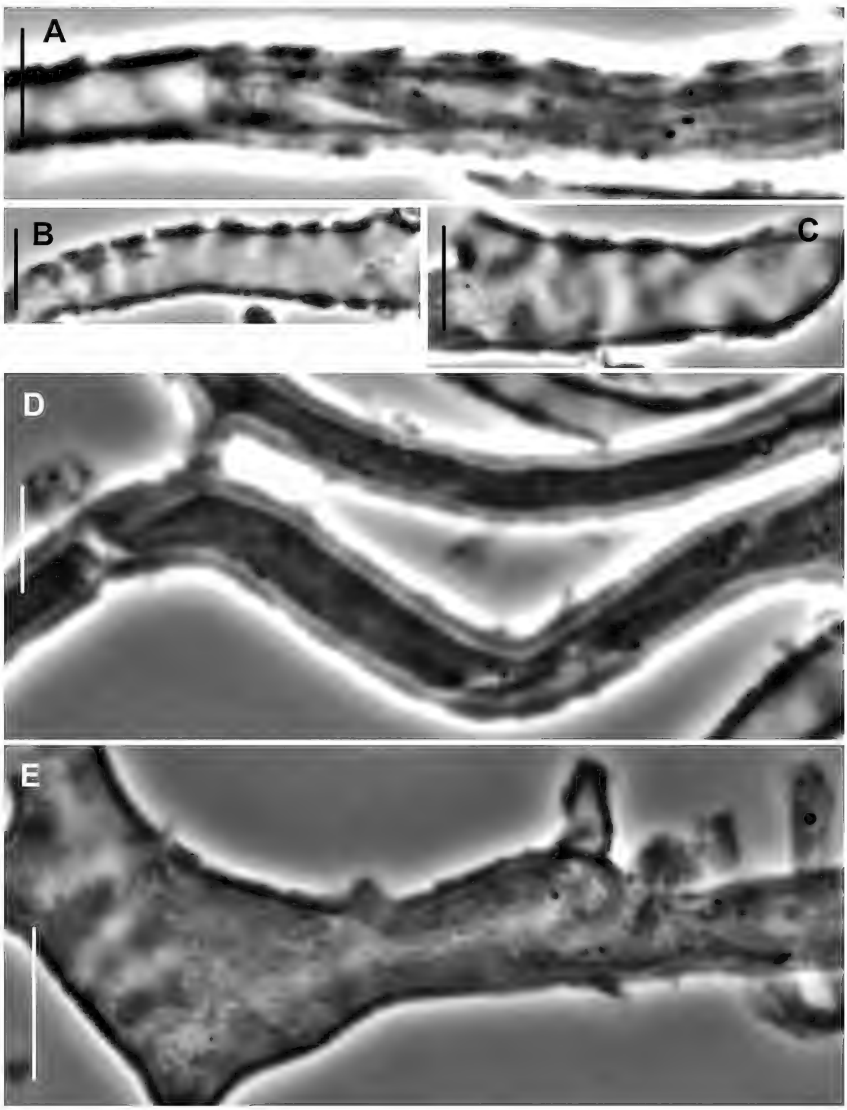

Fig. 11. *Paramycetinis caulocystidiatus* (TENN-F-054050). Pileipellis elements. A. Heavily encrusted hypha with gelatinized wall. B,C. Encrusted hyphae with suggestion of striped or annular ornamentation. D. Hyphae with gelatinized walls. Note anastomosis in "H"-connection. E. Swollen subpellis hypha. Scale bars: 10 μm.

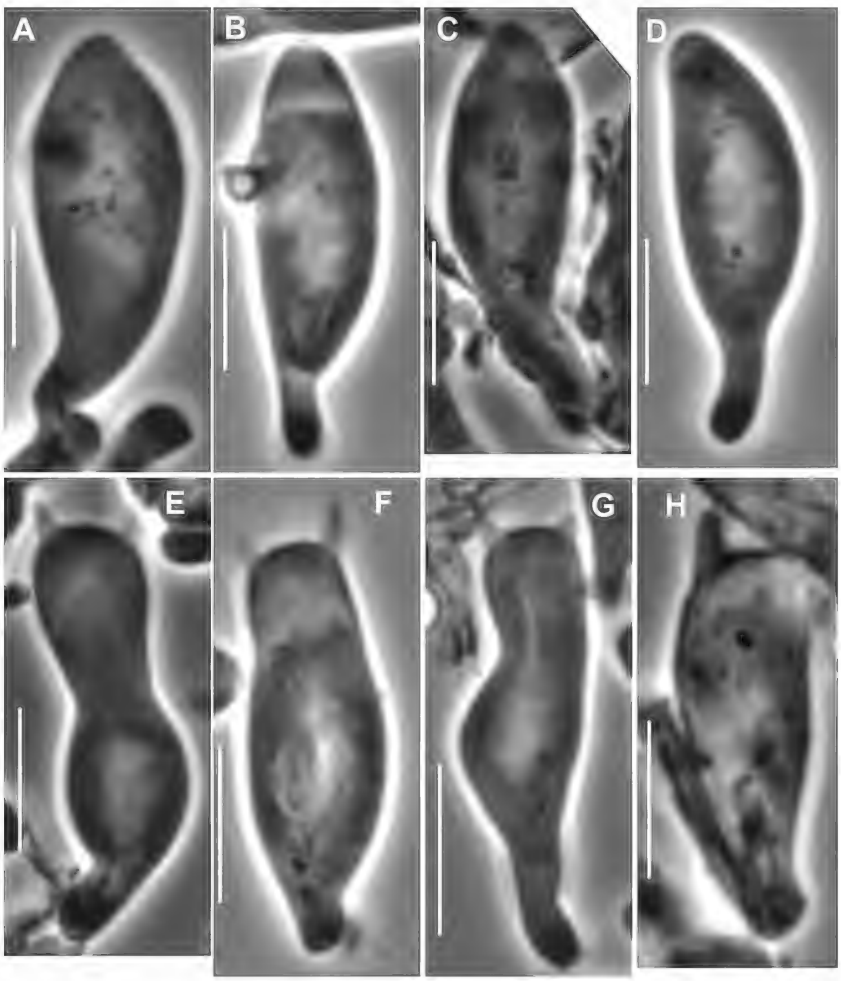

Fig. 12. *Paramycetinis caulocystidiatus* (TENN-F-054050). Hymenial elements. A-D. Pleurocystidia. B. Note partitioned contents. E–H. Basidia. Scale bars: 10 μm.

(PhC), dark red-brown in Melzer's reagent + BF. Caulocystidia (Fig. 14) arising as side branches from thick-walled, smooth, superficial cortical hyphae, stiff, setoid, arising as short lobes (and then hyaline), elongating >70 × 6–9 μm at base, 3–4.5 μm diam at apex, narrowly rounded, thick-walled (wall ≤3 μm thick when visible), sub-refringent and hyaline distally (150× + PhC), strongly dextrinoid (red-brown in Melzer's reagent + BF; dark red-brown in Melzer's reagent + PhC).

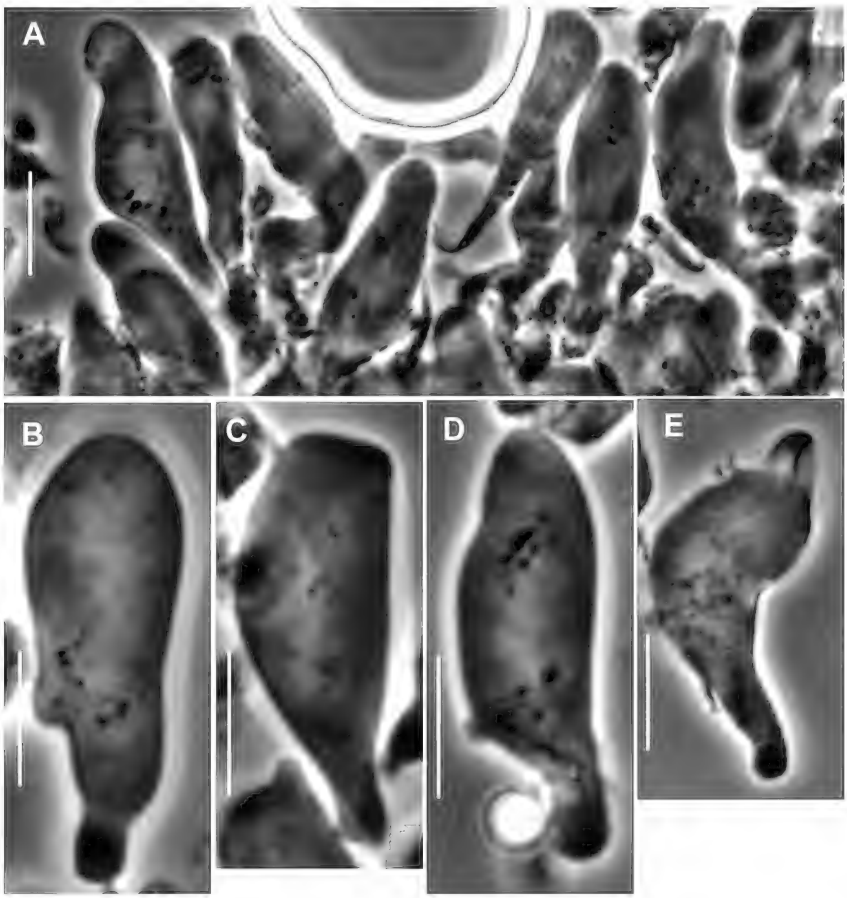

Fig. 13. *Paramycetinis caulocystidiatus* (TENN-F-054050). Cheilocystidia. A. Grouped at lamellar edge. B–E. Individual cheilocystidia. Scale bars: 10 µm.

Commentary: Pileipellis structure is typical of *Gymnopus* sect. *Perforantia*. Hyphal types match quite well, especially gelatinizing hyphal walls and presence of pileal hairs, and there is evidence of a thin slime matrix. Stipe to pileus ratio is high, with the stipe universally vestured and minutely barbed. Dried pileus now somewhat campanulate, with umbo slightly darker than limb or margin; pileus now appearing somewhat moist-laccate. Basidiomata are accompanied by thin, ascendant rhizomorphs. The "omnipotent" stipes and rhizomorphs are somewhat unique, and are quite obvious as abrupt, odd, asymmetrical joints of such structures (see Fig. 9).

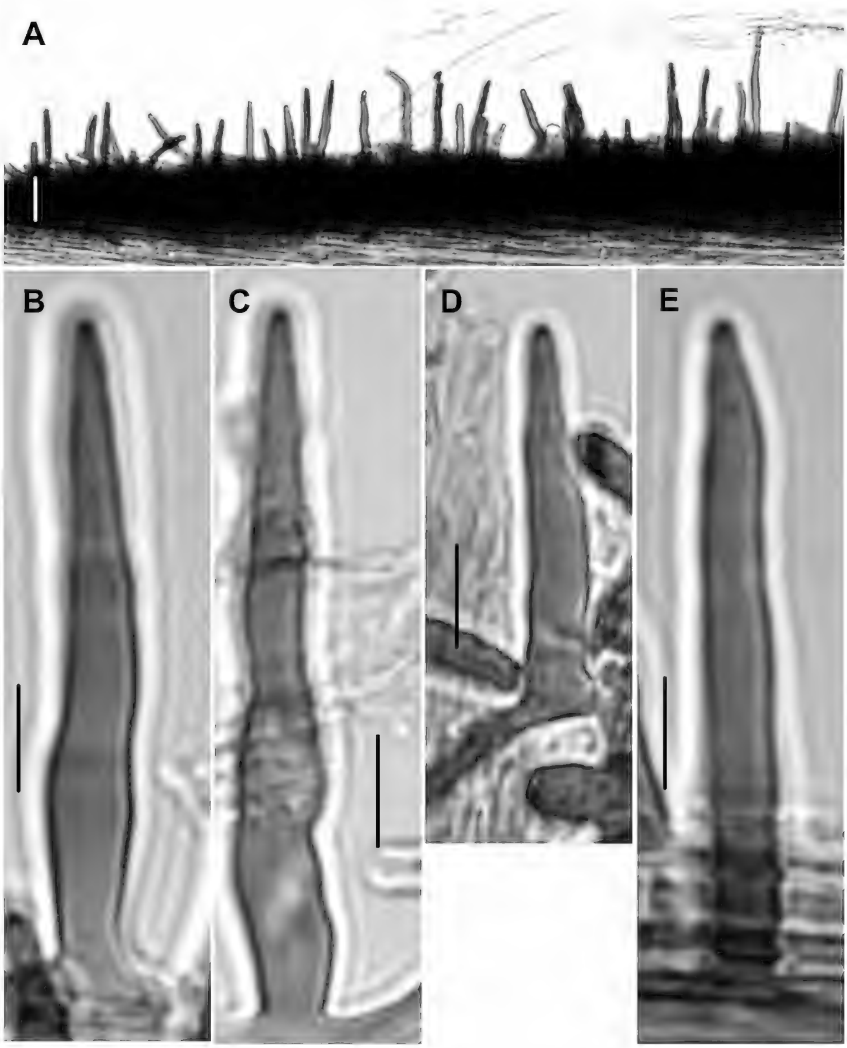

Fig. 14. *Paramycetinis caulocystidiatus* (TENN-F-054050). Caulocystidia.
A. Overview of stipe surface; note gregarious but separate individual caulocystidia.
B–E. Individual caulocystidia. Scale bars: A = 20 µm; B–E = 10 µm.

Paramycetinis caulocystidiatus joins *Pa. austrobrevipes* in a small clade sister to that of *Mycetinis* (Fig. 1). The latter is characterized by a roughly hymeniform pileipellis of inflated, naked, thin-walled cells and usually a basidiomatal alliaceous odor and taste. Wilson & Desjardin (2005) showed that

Mycetinis taxa were found embedded among taxa of *Gymnopus* s.l. and assorted other genera. Petersen & Hughes (2017b) surveyed *Mycetinis*, with a detailed ITS-based phylogeny of the genus.

On whole wheat flour agar (Farnet & al. 1999), cultures of *Pa. caulocystidiatus* produced no textura intricata, white to off-white felty mycelium, and no rhizomorphs.

Additional specimens examined: **NEW ZEALAND, North Island, Urewera National Park**, Lake Waikaremoana, Black Beech Track, 28.V.1994, coll. A.S. Methven, TFB 7588 (TENN-F-053721); Lake Waikareiti Track, 27.V.1994, coll. A.S. Methven, TFB 7572 (TENN-F-053683).

Pseudomarasmius

Oliveira & al. (2019) resolved a clade they named /pallidocephalus (not a genus name). It is this clade that we propose as *Pseudomarasmius*. They encouraged generic status for the clade which, they admitted, needed more research.

Oliveira & al. (2019) proposed *Pusillomyces*, closely related to *Gymnopus asetosus* and *G. funalis* (their clade B). *Pusillomyces manuripioides* (typus generis) was described as lacking clamp connections, a trait virtually diagnostic for *Pseudomarasmius*, proposed here, but relatively unrelated to their clade B.

A PhyML analysis of nrITS sequences for species within *Pseudomarasmius* is given in Fig. 15 and broader placement based on the nrLSU region is given in Fig. 1. *Pseudomarasmius* comprises several species and an unidentified clade of fungal soil isolates from Guyana.

Pseudomarasmius R.H. Petersen & K.W. Hughes, **gen. nov.**

IF 317324

Differs from *Marasmius* by 1) diverticulate hyphae present in the pileipellis and 2) clamp connections absent.

Type species: *Pseudomarasmius pallidocephalus* (Gilliam) R.H. Petersen

Etymology: Referring to its similarity to *Marasmius*.

Basidiomata of three types: 1) similar in size and stature to those of *Gymnopus* sect. *Androsacei*, with discrete, bristle-like stipe and convex to applanate cap; rhizomorphs slender and inconspicuous limited to rotting leaf or needle litter; 2) similar in size and shape to those of *Marasmiellus*, with small, curved stipe and shell-like pileus and usually dominant rhizomorphs which occasionally produce basidiomata as side branches, similar to this phenomenon in *Marasmius crinis-equi*; and 3) small,

slender, pallid yellowish mycenoid basidiomata lacking rhizomorphs, on rotting needles of *Abies* or *Picea*. Microstructures resembling those of *Gymnopus* sect. *Androsacei* and *Marasmius* sect. *Sicci*, including: 1) diverticulate hyphae in pileipellis (arranged in a "rameales-structure"); 2) thick-walled, gelatinizing hyphae and/or gelatinizing diverticulate hyphae in pileipellis and subpellis; 3) without clamp connections or clamps rare and restricted to pileus trama; 4) basidia (2–)-4-spored; 5) spores similar to those of other gymnopoid genera, ellipsoid, thin-walled, inamyloid; 6) molecular (LSU, ITS) profiles unique, grouping into a monophyletic clade related to *Rhodocollybia* but more distant from groups exhibiting similar basidiomatal types (Fig. 15).

Key to species of *Pseudomarasmius*

1. Ratio of pileus breadth to stipe length <2 ("thumb-tack shaped"); basidiomata small, often arising as side branches of rhizomorphs 2
1. Ratio of pileus breadth to stipe length >4; basidiomata marasmioid or mycenoid, arising as rhizomorph branch or independently on leaf litter or woody substrate 3

2. Southern South America (Isla Chiloé, Chile); rhizomorphs inconspicuous, not producing basidiomata; fruiting on hardwood substrates; clamp connections absent; superficially inseparable from *Ps. nidus-avis* ..... ***Ps. patagonianus***
2. North American Gulf Coastal Plain and subtropical eastern Mexico; rhizomorphs dominant, long, occasionally branched, occasionally producing basidiomata as side branches; fruiting on small dead branches and twigs of deciduous trees usually at some distance from the ground; clamp connections occasional in rhizomorphs and tramae but otherwise absent ..... ***Ps. nidus-avis***

3. Antipodal (New Zealand); basidiomata minute (pileus 1–3.5 mm broad; stipe capillary, 6–8 mm long); fruiting on hanging dead terminal branches of *Dacrydium;* ..... ***Ps. efibulatus***
3. Not Antipodal; fruiting substrate leaf or needle litter 4

4. Fruiting on conifer needle litter; rhizomorphs usually inconspicuous 5
4. Fruiting on hardwood leaf litter (including *Castanopsis*); rhizomorphs conspicuous, resupinate on leaf surface 7

5. Temperate to northern North America; stipe black; basidiomata like those of *Gymnopus* sect. *Androsacei* (pileus <35 mm broad; stipe 12–43 × 0.2–0.8 mm); pileus white to off-white; rhizomorphs inconspicuous, usually found deep in humus ..... ***Ps. pallidocephalus***
5. South Korea/eastern North America; basidiomata slender, mycenoid; stipe ochraceous to straw-colored; 6

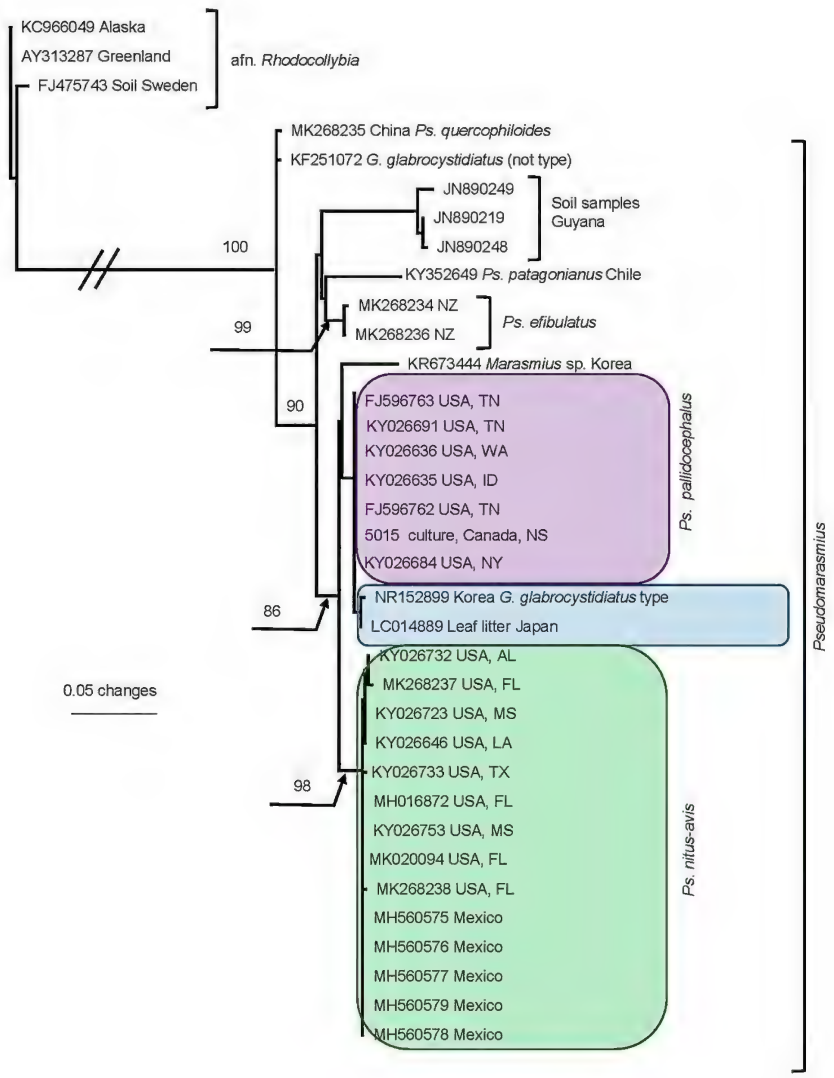

FIG. 15. Maximum likelihood analysis of ribosomal RNA ITS sequences. Bootstrap values are given to the left of the supported node. Numbers are GenBank accession numbers (See TABLE 1). For collections from the United States and Canada, the state or province postal code is given. NZ = New Zealand.

6. South Korea (and probably Japan); basidiomata minute, fragile (pileus 48 mm broad; stipe 15–40 × 0.5 mm); pileus dark grey-green; stipe dark brown to black-brown; rhizomorphs inconspicuous; fruiting on dead needles of *Abies* ..... ***Ps. glabrocystidiatus***
6. Eastern North America; basidiomata similar to those of *Ps. glabrocystidiatus*; pileus light brown or pale greyish brown; stipe brownish orange to yellow or straw-colored; on rotting needles of *Picea* and *Abies* ..... ***Ps. straminipes***
7. Costa Rica; high-altitude *Quercus* forests ..... ***Ps. obscurus***
7. South Korea, China (Yunnan); on dead leaves of *Castanopsis* ... ***Ps. quercophiloides***

Pseudomarasmius efibulatus R.H. Petersen, **sp. nov.** FIGS 16–20

IF 555730

Differs from *Pseudomarasmius* taxa by its: 1) minute basidiomata; 2) fruiting habit on dead *Dacrydium* branchlets; 3) scattered pyramidal to digitate diverticula on pileipellis elements; 4) known distribution limited to the New Zealand type location.

TYPE: New Zealand, South Island, Westland, Fox Glacier, Lake Matheson loop trail, 43°26′22″S 169°57′54″E 13.V.1994, coll. RHP, TFB 7070 (TENN-F-056187).

ETYMOLOGY: from *fibula* (Latin) for clamp, buckle + *e-* (Latin), without. Referring to the clampless condition.

BASIDIOMATA (FIG. 16A) diminutive. PILEUS 1–3.5 mm broad, convex when young, becoming everted by maturity, matte, pebbled; disc 7C5 ("fawn color"), outward 9B2 ("vinaceous buff") to 6A3 ("pinkish buff"). LAMELLAE adnate, arcuate, not collariate, thickish, c. 1 mm broad, not marginate, off-white when fresh, becoming 5A4 ("light ochraceous buff") over time; lamellulae occasional, short; total lamellae (10)1218; through lamellae 7–8. STIPE 6–8 × 0.2–0.4 mm, apically 8E6 ("Natal brown") (and this color extending through lamellar attachment to pileus flesh), lower 7/8 black, glabrous-shining, insititious. RHIZOMORPHS (FIG. 16A,17) common, <40 × 0.1–0.3 mm, more or less straight (not curly), rarely branched, arising separately from basidiomata.

HABITAT AND PHENOLOGY: On dead, pendant *Dacrydium* foliage; Autumn.

PILEIPELLIS with minimal slime matrix and composed of the following: 1) diverticulate hyphae (FIG. 18A–D) 4.5–10 µm diam, thin-walled, with scattered diverticula ≤10 × 1.52 µm (often c. 4 µm diam at base and therefore more or less pyramidal), often dichotomous or saddle-shaped, not refringent [in fact appearing darker than the parent hyphae in PhC]; 2) broom cell-like termini (FIG. 18E–H) 15–25 × 9–16 µm, stalked, usually dichotomously branched, surmounted with rows of diverticula; diverticula 3–8 × 1–1.5 µm, hardly refringent (PhC). Pileus tramal hyphae 3–6 µm diam, firm-walled, long-celled, apparently without clamp connections; wall somewhat obscure,

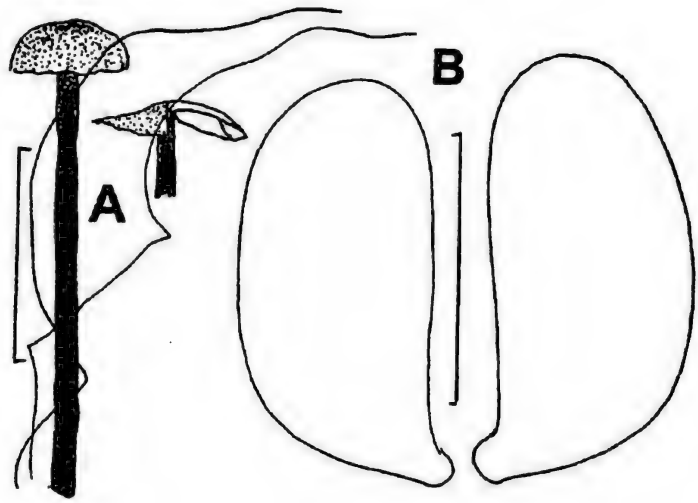

Fig. 16. *Pseudomarasmius efibulatus* (TENN-F-056187, holotype).
A. Basidiomata and rhizomorphs. B. Basidiospores. Scale bars: A = 5 mm; B = 5 µm.

as though semi-gelatinized. Lamellar tramal hyphae similar. Hymenium apparently involved in minimal gelatinized matrix (excessive hymenial remnants and other debris). Pleurocystidia (Fig. 19A–D) 24–30 × 6–7 µm, fusiform, often irregularly so, without content partitioning or clamp connection. Basidioles clavate, usually subcapitulate; Basidia (Fig. 19E–H) 22–30 × 6–9 µm, clavate, 4-sterigmate, without clamp connections. Basidiospores (Fig. 16B) (7–)7.5–11 × 3.5–4.5 µm (Q = 2.053.14; Q^m = 2.26; L^m = 8.67 µm), elongate-ellipsoid to subcylindrical, more or less marasmioid (somewhat tapered proximally), flattened somewhat adaxially, thin-walled, smooth, inamyloid. Lamellar edge apparently fertile. Cheilocystidia (Fig. 20) widely scattered, 22–35 × 10–12 µm, stalked-clavate to saccate, entire or with a few slender, digitate apical processes, without clamp connections. Stipe medullary hyphae 1.5–12 µm diam, strictly parallel, involved in a slime matrix, thin- to thick-walled (wall c. 0.7 µm thick, hyaline), distinctly without clamp connections, relatively short-celled; subcortical hyphae 4–8 µm diam, thick-walled (wall c. 1.5 µm thick), strongly refringent, yellow (PhC). Stipe cortical hyphae 4–7 µm diam, firm-walled, short-celled, without clamp connections, pigmented yellow-olive (PhC); surface minutely roughened with dried thin slime. Caulocystidia absent.

Fig. 17. *Pseudomarasmius efibulatus* (TENN-F-056187, holotype). *Dacrydium* branchlets with rhizomorphs. Scale bar = 10 mm.

Commentary: Based on ribosomal nrRNA ITS sequences, *Ps. efibulatus* is related to but distinct from *Ps. pallidocephalus*, *Ps. glabrocystidiatus,* and *Ps. nidus-avis*. It is closely related to sequence JAC10695 received from J. Cooper, Landcare Research, New Zealand (Fig. 15)

A blast of ITS sequence from *Ps. efibulatus* (TFB 7070, TENN-F-056187) showed an affinity with ITS sequences of *Ps. glabrocystidiatus*, a clampless taxon from South Korea, placed by its authors in *Gymnopus* sect. *Androsacei.* Sequences of *Ps. glabrocystidiatus* are virtually congruent to those of *Ps. pallidocephalus* (see above) found frequently across northern North America fruiting on dead conifer needles, also the habit of the Asian *G. glabrocystidiatus*. The nrITS-based phylogeny produced by Antonín & al. (2014) placed *G. glabrocystidiatus* within *Gymnopus* but on a long, independent branch described as part of *G.* sect. *Androsacei.* The nrLSU-based phylogeny in Fig. 1 (above) indicates even more significant isolation of *Pseudomarasmius*.

Pseudomarasmius efibulatus belongs to a small complex of similar, slender, gracile basidiomata along with *Ps. straminipes* and *Ps. glabrocystidiatus*, but the basidiomata of all three species are so small and inconspicuous as to be

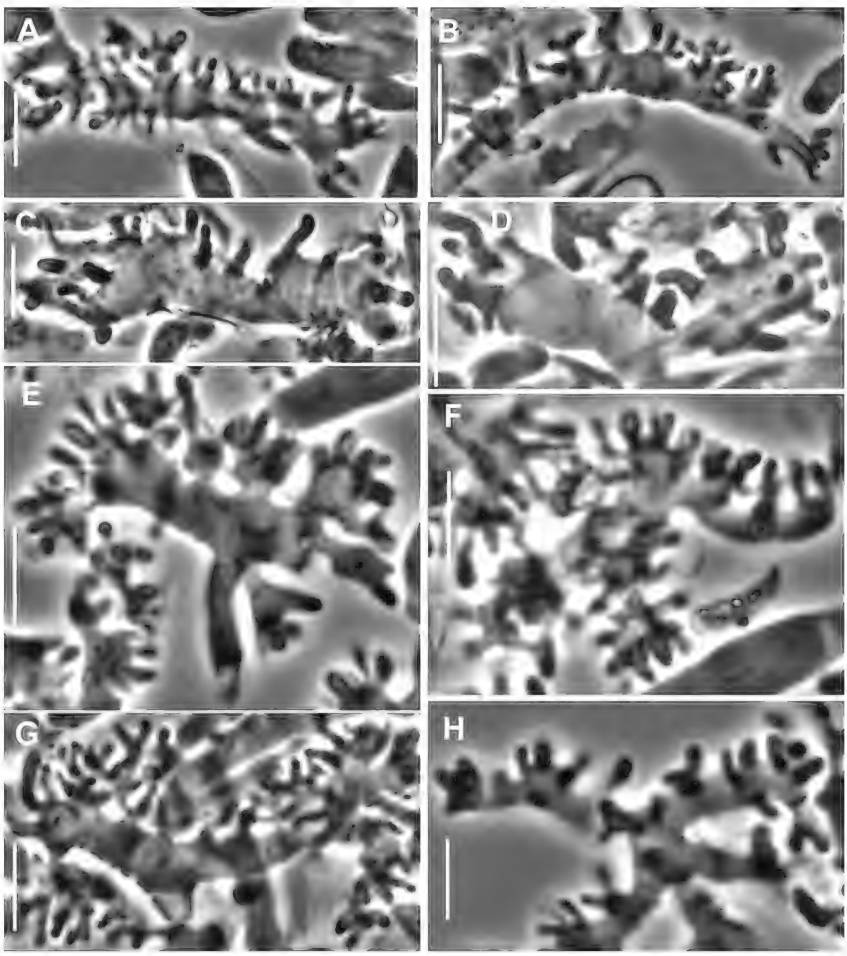

Fig. 18. *Pseudomarasmius efibulatus* (TENN-F-056187, holotype). Pileipellis elements. A–D. Diverticulate hyphae. E–H. Broom cell-like hyphal termini. Scale bars: 10 μm.

easily overlooked. *Pseudomarasmius efibulatus,* however, is quite isolated in substrate and distribution.

The few similarities between *Ps. pallidocephalus* and *Ps. efibulatus* include: 1) clampless condition; 2) temperate distribution (North- and South-Temperate climates); 3) stipe without caulocystidial ornamentation; 4) a complex "*ramealis*-structure" of pileipellis; 5) cheilocystidia that are usually smooth, broadly clavate or ampulliform; and 6) well-developed rhizomorphs.

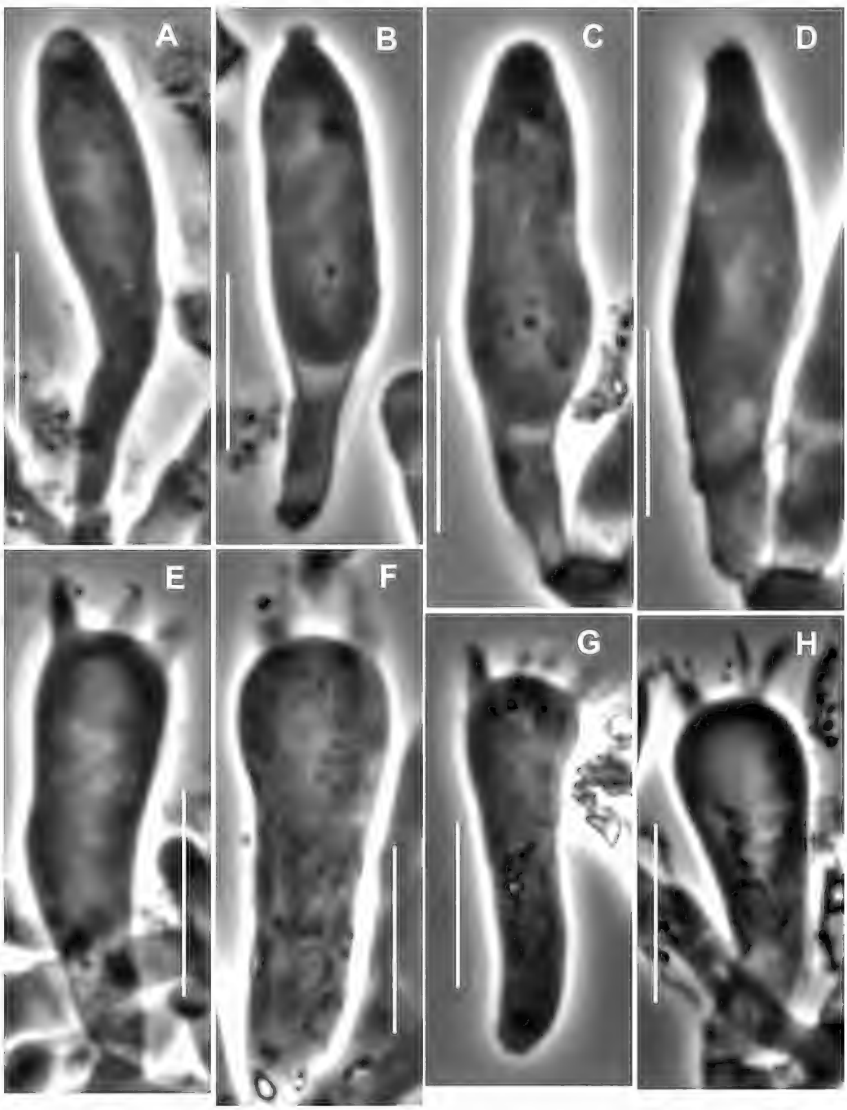

Fig. 19. *Pseudomarasmius efibulatus* (TENN-F-056187, holotype). Hymenial elements. A–D. Pleurocystidia. E–H. Basidia. Scale bars: 10 µm.

Basidiospores are smooth, ellipsoid to elongate pip-shaped, and white in spore deposits throughout the /gymnopus/marasmiellus clade, with spore measurements distinguishing the taxa reported as follows: *Ps. efibulatus* = (7–)7.5–11 × 3.5–4.5 µm (Q = 2.26); *G. glabrocystidiatus* = (7.7–)8.5–9.5

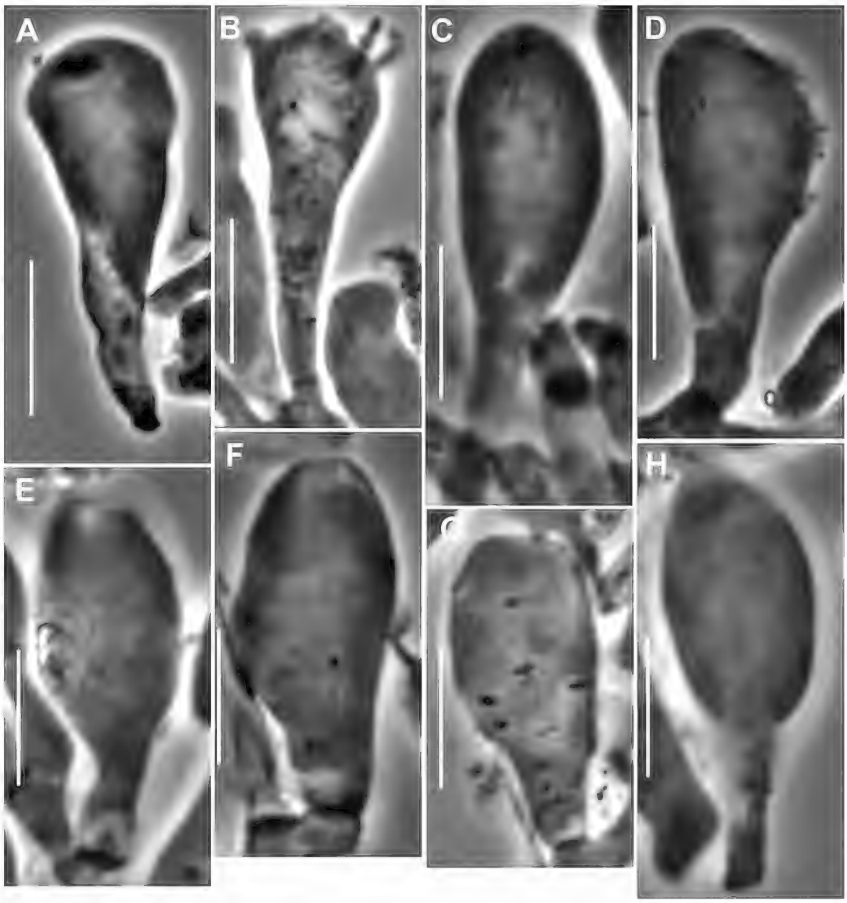

Fig. 20. *Pseudomarasmius efibulatus* (TENN-F-056187, holotype). Cheilocystidia. Scale bars: 10 µm.

(–10) × 4–5 µm (Q = 2); *Ps. pallidocephalus* = (5–)5.5–7(–9.5) × 3–3.5 µm (Q = 1.87).

Macroscopically, basidiomata of *Ps. nidus-avis* and *Ps. patagonianus*, superficially resemble numerous *Marasmiellus* taxa fruiting on dead twigs and small branches of deciduous trees and exhibiting extensive, robust rhizomorphs. Although morphologically counterintuitive for inclusion in *Pseudomarasmius*, ITS- and LSU-based phylogenies place *Ps. nidus-avis* and *Ps. patagonianus* with the other taxa in the genus.

Perhaps most surprising about the sole collection of *Ps. efibulatus* was the absence of clamp connections. Collections of similar basidiomata found fruiting on the same somewhat unique substrate demonstrated ubiquitous clamp connections. Moreover, pileipellis elements of clamped and clampless organisms compare well: a complex pileipellis composed of both repent diverticulate hyphae (with diverticula often bifurcate) and broom cell-like hyphal termini beset with diverticula also often dichotomous. This may be analogous to the situation in *Ps. straminipes* (clampless) and its form *fibulatus* (clamp connections ubiquitous). DNA sequences not currently extant may help to clarify this situation.

Pseudomarasmius glabrocystidiatus (Antonín, Ryoo & Ka) R.H. Petersen, **comb. nov.** FIGS 16–20

IF 555747

≡ *Gymnopus glabrocystidiatus* Antonín, Ryoo & Ka, Mycol. Prog. 13(3): 710. 2014. Republic of Korea, Inje, Baekdam-sa, 27. VI. 2008 leg. V. Antonín (08.36), R. Ryoo & J.G. Han (**Holotype**, BRNM 718676).

ADDITIONAL PUTATIVE CONTAXIC COLLECTION (but see below): Culture. Korea, Jeju, Seonheul-gotjawal, 06.IX.2012, R. Ryoo, K.-H. Ka & H.D. Sou (KFRI 1935).

For detailed description and illustrations see Antonín & al. (2014)

Major distinguishing characters include: 1) basidiomata similar to those of *Ps. straminipes*; 2) clamp connections absent; 3) pileus dark (grey-)brown with paler margin when young, then brownish at center and paler, beige to pale brown at margin; 4) basidia 2- spored; 5) stipe smooth and glabrous, dark brown to black-brown; 6) cheilocystidia smooth, clavate or pyriform; 7) pileipellis composed of more or less smooth or diverticulate hyphae and single broom cells; 8) habitat on dead conifer (*Abies*) needles; 9) geographic distribution, South Korea (probably Japan).

HABITAT: needles of *Abies holophylla*.

COMMENTARY: In the phylogeny presented by Antonín & al. (2014), two ITS sequences of putative *Gymnopus glabrocystidiatus* (GB NR152899, holotype; KF251072, ancillary sequence from culture) appeared in a single small clade but on individual short branches. This clade appears sister to *Rhodocollybia*, a position similar to that shown on our LSU-based phylogeny (FIG. 1) for *Pseudomarasmius*. An ITS sequence from holotype material of *G. glabrocystidiatus* differs from those of *P. pallidocephalus* by 31/694bp (4.46%) and while apparently in the same clade based on nrITS sequences alone (FIG. 15), nrITS sequence divergences warrant separate species designations. Further, *G. glabrocystidiatus* is an Asia taxon while

Ps. pallidocephalus is North American in distribution. The description and illustrations of *Ps. glabrocystidiatus* furnished by Antonín & al. (2014) are adequate and require no enhancement here.

Although two GenBank designations for ITS sequences of *G. glabrocystidiatus* were reported in the phylogeny by Antonín & al. (2014), KP251073 ("NR152898" from holotype material) and KP251072, the latter can be traced to a culture from an ancillary specimen apparently misidentified. The two sequences appear only distantly related in our ITS-based phylogeny (Fig. 15).

The non-type GenBank sequence (KF251072) virtually matches that of TFB 3162, here proposed as *Ps. quercophiloides* (q.v.). The latter was collected in China.

GenBank sequence LC014889, including the ITS region, was derived from an environmental sample from leaf litter of *Picea jezoensis* subsp. *hondoensis* (spruce) in Funabashi, Japan (Hagiwara & al. 2015). The sampling site was in central Honshu Island (35 36'N, 13728'E) and dealt with bleaching of substrate leaf debris, including conifer (Hintikka 1970; Miyamoto & al. 2000; Osono 2015). The spruce substrate generally agrees with that of *Ps. glabrocystidiatus* and, with the latter distribution in South Korea (Antonín & al. 2014), the Japanese report seems within the ecological pattern for the complex.

Pseudomarasmius nidus-avis (César, Bandala & Montoya) R.H. Petersen, **comb. nov.** Figs 21–31

IF 555746

≡ *Gymnopus nidus-avis* César, Bandala & Montoya, Mycokeys 43: 25. 2018

Type: Mexico. Veracruz: Municipality of Xalapa, Santuario del Bosque de Niebla, Instituto de Ecología A.C., 1343 m a.s.l., gregarious, on fallen twigs of *Quercus*, 20 April 2016, Cesar 36 (Holotype, XAL).

Diagnostic characters include 1) basidiomata that are small and thumb tack-shaped, often arising as side branches from rhizomorphs; 2) a short, curved stipe; 3) distribution in North American Gulf Coast and subtropical Mexico; 4) clamp connections lacking except rare in stipe medulla.

Basidiomata (Figs 21, 22) arising from woody substrate or (more often) as side branches of rhizomorphs. Pileus 2–6(2–10) mm broad, convex to plano-convex, usually somewhat depressed over the disc, occasionally shallowly umbonate, pulvinate, variously sulcate-striate, matt, uniformly more or less "wood brown" (7C4), pale brown (7.5 YR 7/4–6; 10YR 7/4; Munsell) to brown (7.5 YR 5/6; 10 YR 4/4; Munsell); context thin (<1 mm

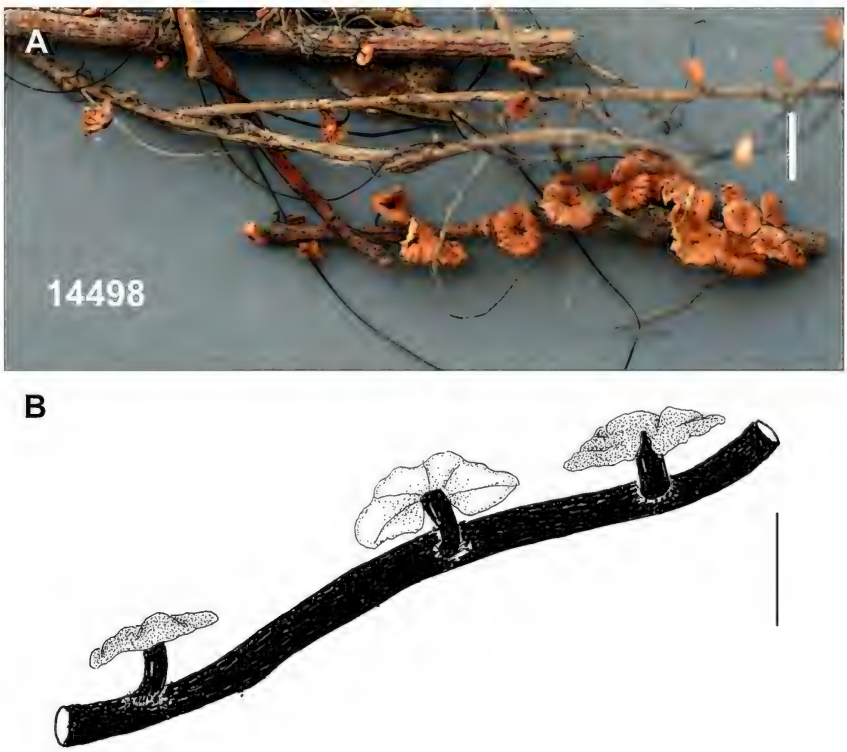

Fig. 21. *Pseudomarasmius nidus-avis* (TENN-F-054912). Basidiomata.
A. Habit photo. B. Basidiomata, macromorphological aspect. Scale bars: 10 mm.

thick), soft, whitish. Lamellae (<1 mm broad; 13–26 total lamellae, 4–9 through lamellae, anastomoses lacking), adnate, adnexed to shallowly subdecurrent, thick with rounded edge, paler than pileus surface, ivory to off-white when fresh, very pale brown (2.5 Y 8/2; Munsell)], after drying suffused ruddy brownish outward from stipe (now "wood brown" 7C4, or "avellaneous" 7B3); lamellar edge entire. Stipe arising either from woody substratum or as side branches of rhizomorphs; 2–6(–12) × (0.2–)0.7(–1.6) mm, central to slightly eccentric, terete, equal or tapered downward, black, glabrous-shining, straight to strongly curved, insititious, reddish-brown at the apex (2.5 YR 4/6; Munsell), dark brown to black below (10YR 2/1, 7.5YR 2.5/2; Munsell), brown; medulla light brown (2.5Y 6/4; Munsell;

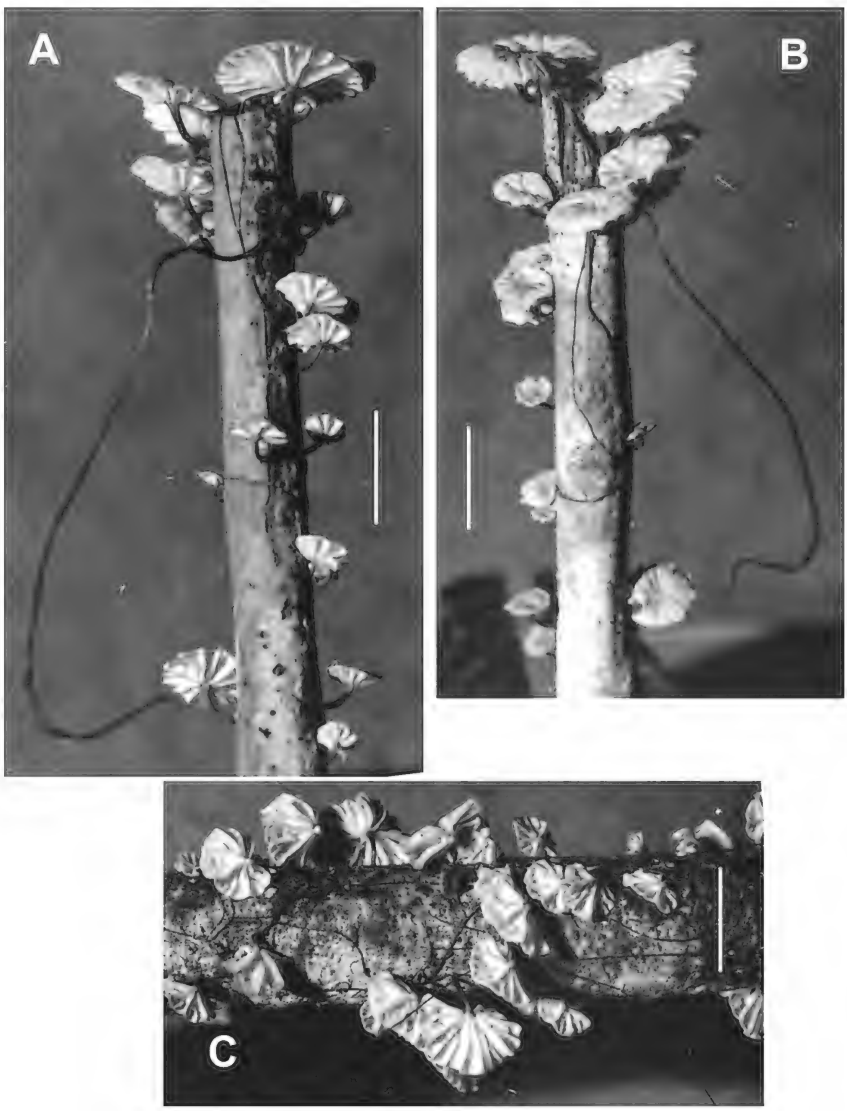

Fig. 22. *Pseudomarasmius nidus-avis* (TENN-F-047666). Basidiomata. Scale bars: 10 mm. Photos courtesy David P. Lewis.

basal tuft very sparse). Rhizomorphs (Fig. 21, 22a,b) ≤500 × 0.1–0.3 mm, simple, black, wiry, abundant, black, glabrous-shining. Taste and odor not distinctive.

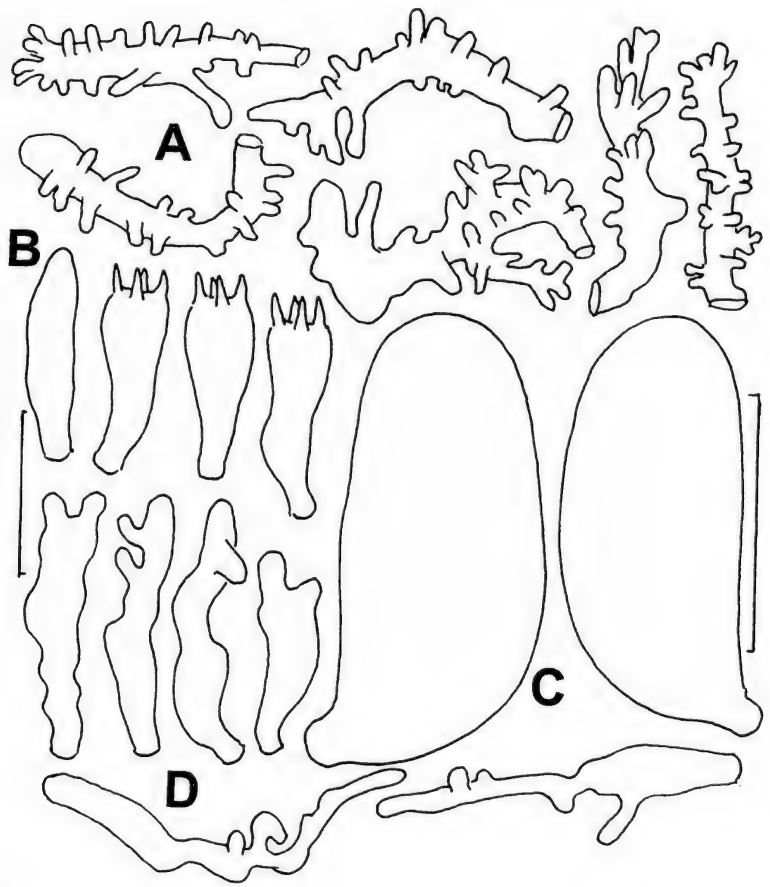

Fig. 23. *Pseudomarasmius nidus-avis* (TENN-F-054912). Micromorphology. A. Pileipellis diverticulate hyphae. B. Pleurocystidium and basidia. C. Basidiospores. D. Cheilocystidia. Bars: A-C = 10 µm; D = 5 µm.

Habitat & phenology: Subtropical forest, with dominant rhizomorphs scattered or gregarious on fallen or aerial twigs of trees, notably *Quercus*, with rhizomorphs used by birds as nesting material in Mexico; late spring and summer; North American Gulf of Mexico Coastal Plain (Alabama, Florida, Louisiana, Mississippi, Texas).

Pileipellis composed of: 1) pileal hairs (Fig. 24a–c) <80 × 2–4 µm, possibly erect, becoming apically subcapitulate, minutely ornamented; 2) repent diverticulate-ornamented hyphae (Figs 23a,25), 2.5–5.5 µm diam,

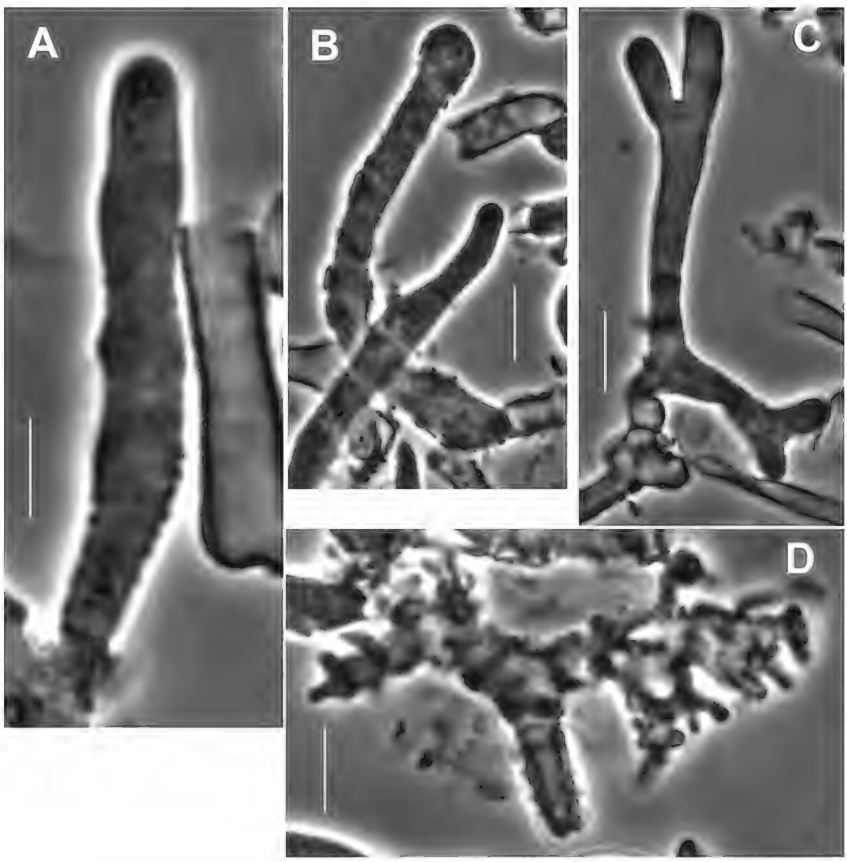

Fig. 24. *Pseudomarasmius nidus-avis* (TENN-F-054912). Micromorphology. A–C. Pileal hairs. D. Broom cell-like pileipellis hyphal terminus. Bars = 10 µm.

thick-walled and diverticulate hyphae termini (Figs 24D,25); diverticula 1–3 × 1–1.5 µm, conical, slightly dextrinoid (fide César & al. 2018); clamp connections absent; 3) tightly interwoven, repent hyphae 2.5–6 µm diam, thick-walled (wall <1 µm thick), ornamented with annular deposits c. 0.5 µm thick (Fig. 26A,B); 4) repent hyphae 2–4.5 µm diam, thick-walled (wall <1 µm thick) with individual slime sheath. Pileus trama composed of interwoven hyphae 2.5–7.5 µm diam, weakly dextrinoid (fide César & al. 2018), individually strongly gelatinized (wall <2.5 µm thick, hyaline), implicitly ornamented with flake-like deposits (seen as carried by individual slime sheath; Fig. 26C,D); clamp connections absent. Lamellar trama loosely

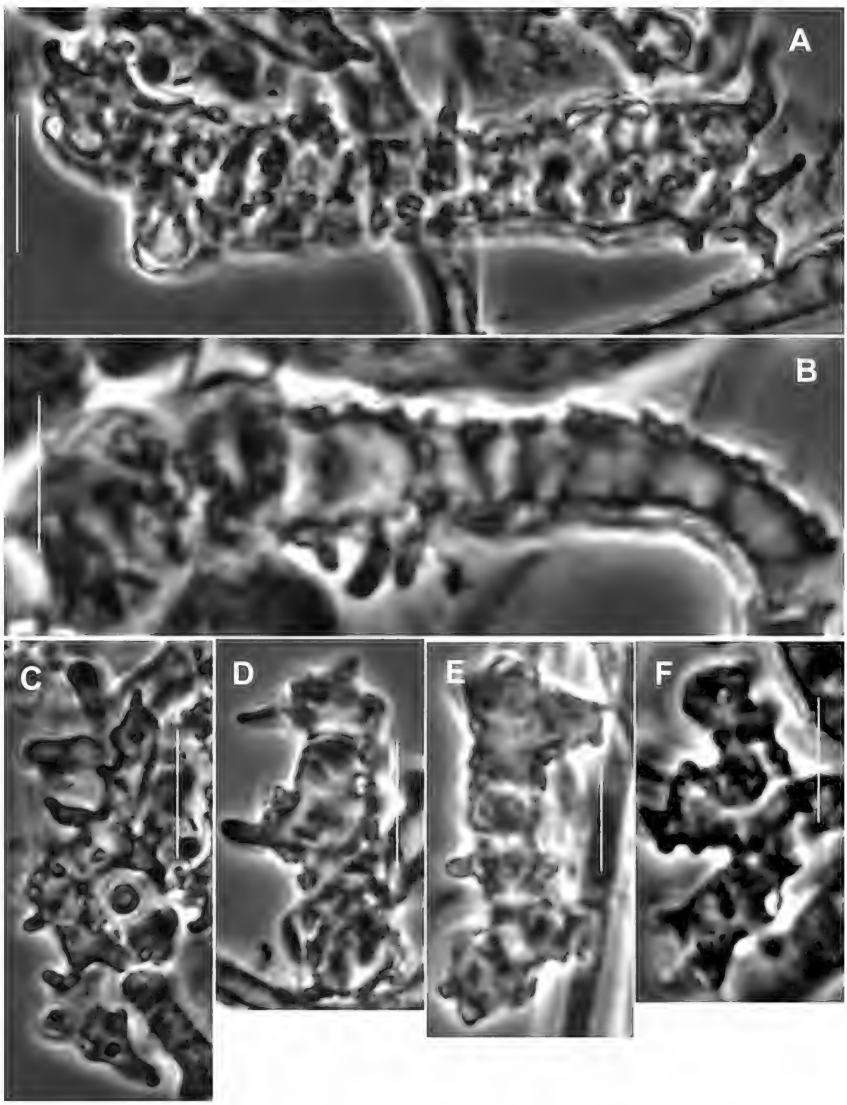

Fig. 25. *Pseudomarasmius nidus-avis* [FLAS-F-60891]. Pileipellis diverticulate hyphae. Compare with Figs 38–40 (*Ps. pallidocephalus*). Bars = 10 µm.

interwoven; hyphae 2–3.5 µm diam, firm-walled, hardly gelatinizing, not easily disarticulated, inamyloid to weakly dextrinoid (fide César & al. 2018); clamp connections absent. Pleurocystidia (Fig. 23b, 27) common, 24–29

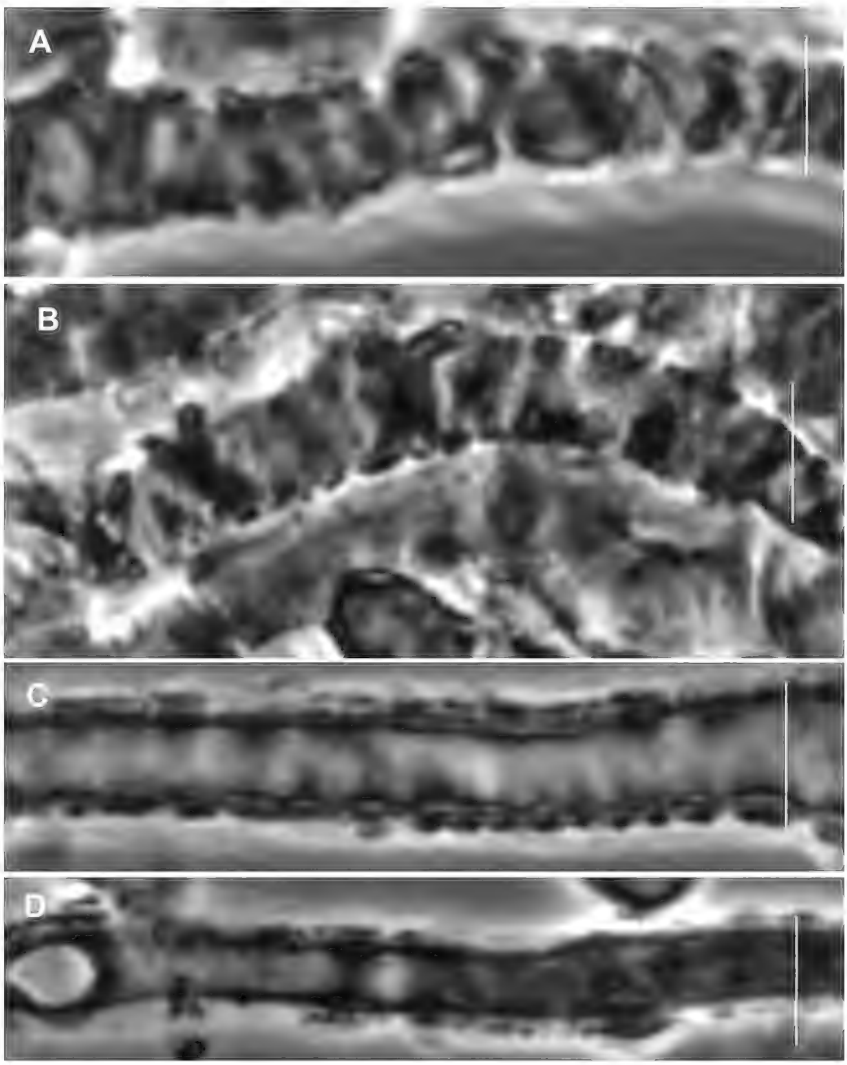

Fig. 26. *Pseudomarasmius nidus-avis* [FLAS-F-60891]. Pileipellis hyphae.
A. Hyphal encrustation in scabs. B. Annular ornamentation. C,D. Individual slime sheaths.
Bars = 10 µm.

× (5–)6–7 µm, fusiform to plump-fusiform, without clamp connections; contents multiguttulate; guttules refringent (PhC). Basidioles (Fig. 28A) clavate becoming subcapitulate, without clamp connections; BASIDIA (Fig. 28B–D) (20–)27–32(–41) × (5–)9–11 µm, clavate to subcapitulate,

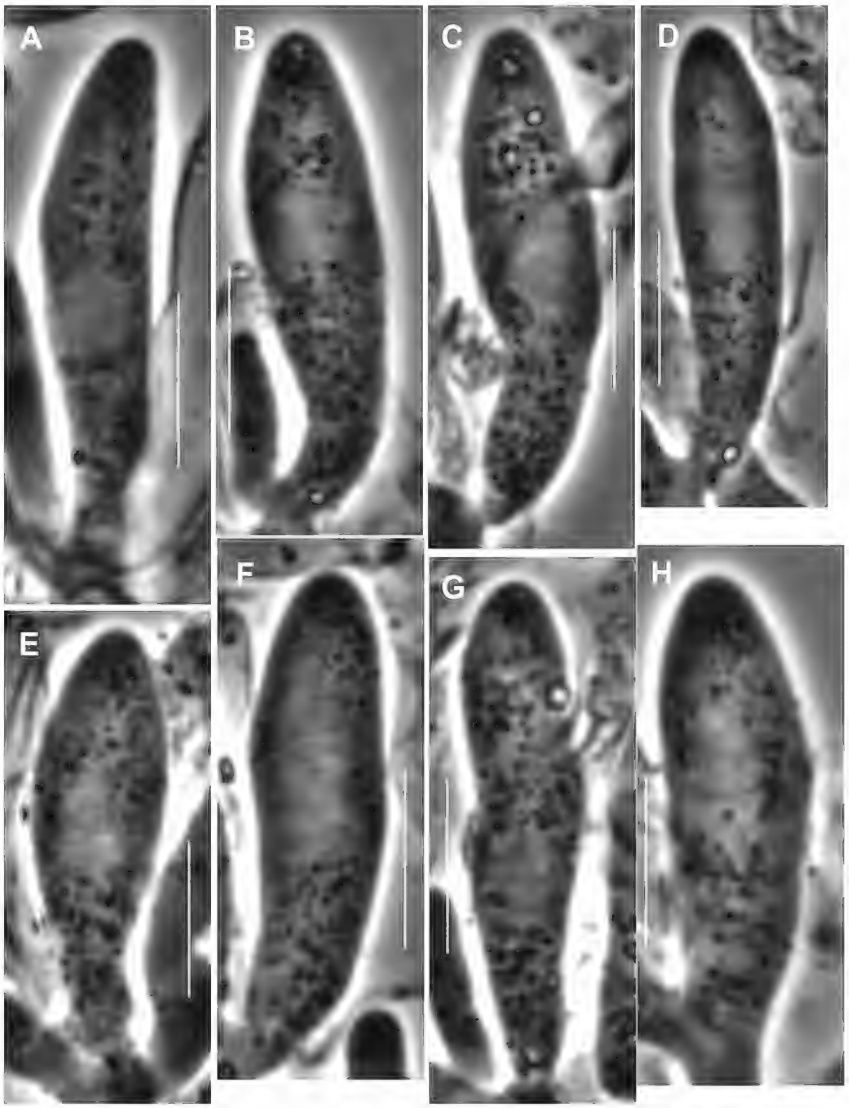

Fig. 27. *Pseudomarasmius nidus-avis* [MES 1477 (FLAS)]. Pleurocystidia. Bars = 10 µm.

(2–)4-sterigmate, without clamp connections; contents multiguttulate; guttules refringent (PhC). Basidiospores (Figs 23c, 28e-h) (7–)8–10.5 × (3–)4–5.5 µm (Q = 1.802.22; Q^m = 1.91; L^m = 9.2 µm), ellipsoid to plump pip-shaped, flattened adaxially, usually somewhat tapered proximally,

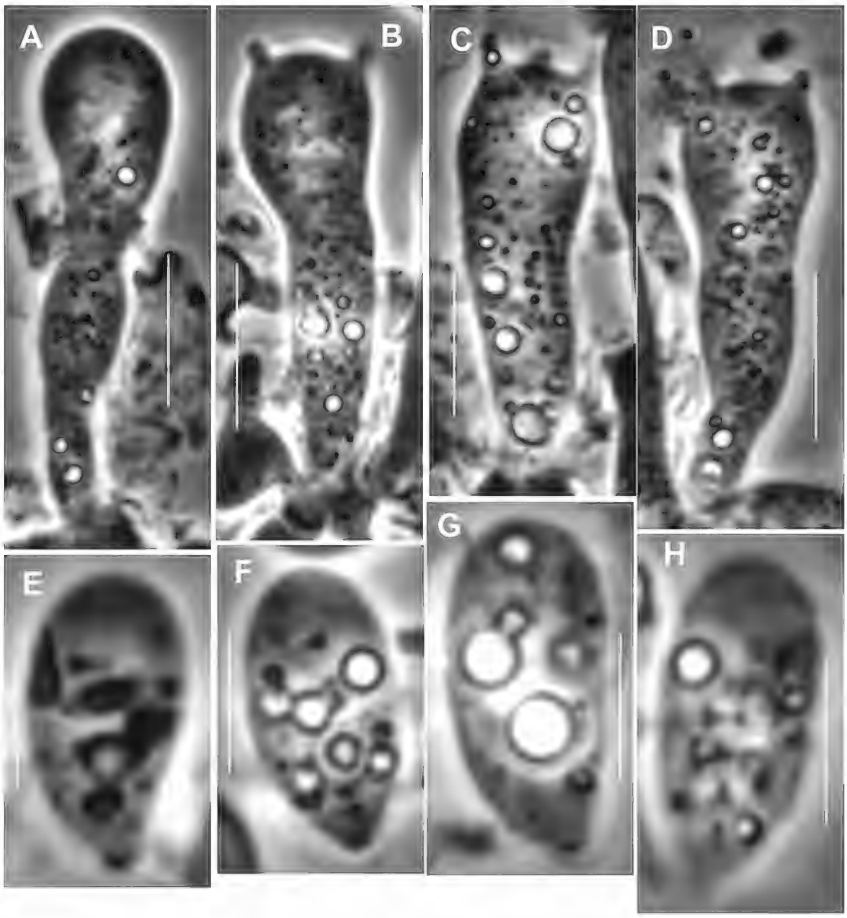

Fig. 28. *Pseudomarasmius nidus-avis* [MES 1477 (FLAS)].
A–D. Basidiole and individual basidia. E–H. Basidiospores. Bars = 10 μm.

hyaline, thin-walled, inamyloid; contents multiguttulate when mature; guttules refringent (PhC). Cheilocystidia (Figs 23d, 29) 20–39 × 3–8 μm, occasional on lamellar edge, hyphal (not inflated), stalked (stalk 2–2.5 μm diam, thin-walled), irregularly lobed and/or branched, without clamp connections; contents homogeneous. Stipe medullary hyphae of two distinct forms: 1) stout hyphae (Fig. 30), 4–15(–30) μm diam, highly refringent (PhC), apparently aseptate or with occasional cloissons d'retret; hyphal walls gelatinizing, occasionally strongly so (wall c. 4.5(–12) μm thick),

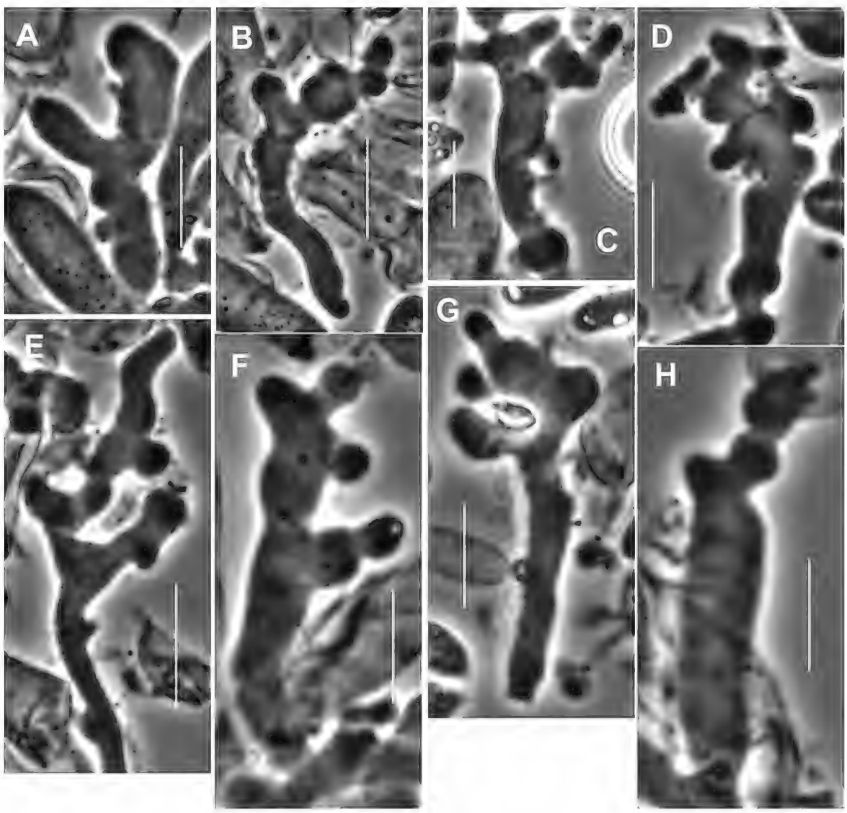

Fig. 29. *Pseudomarasmius nidus-avis* [MES 1477 (FLAS)]. Cheilocystidia. Bars = 10 µm.

often ornamented with flake-like deposits in vague stripes and carried on the outside of the gelatinized sheath; and 2) slender hyphae (Fig. 31), 2–4.5 µm diam, thick-walled (wall c 0.7 µm thick), minutely ornamented, with occasional but conspicuous clamp connections. Stipe cortical hyphae 2.5–7.5 µm diam, repent, strictly parallel, strongly pigmented, thick-walled, minutely encrusted on stipe surface, dextrinoid (red-brown, Melzer's reagent + PhC; reddish brown, Melzer's reagent + BF); pigmented, diverticulate terminal elements 4–19(–21) × 3–4(–5) µm, thin-walled (fide César & al. 2018).

Commentary: A recent paper (César & al. 2018) described *Gymnopus nidus-avis* as clampless (except for scattered clamps in stipe medulla) and with basidiomata arising as side branches from copious, black rhizomorphs.

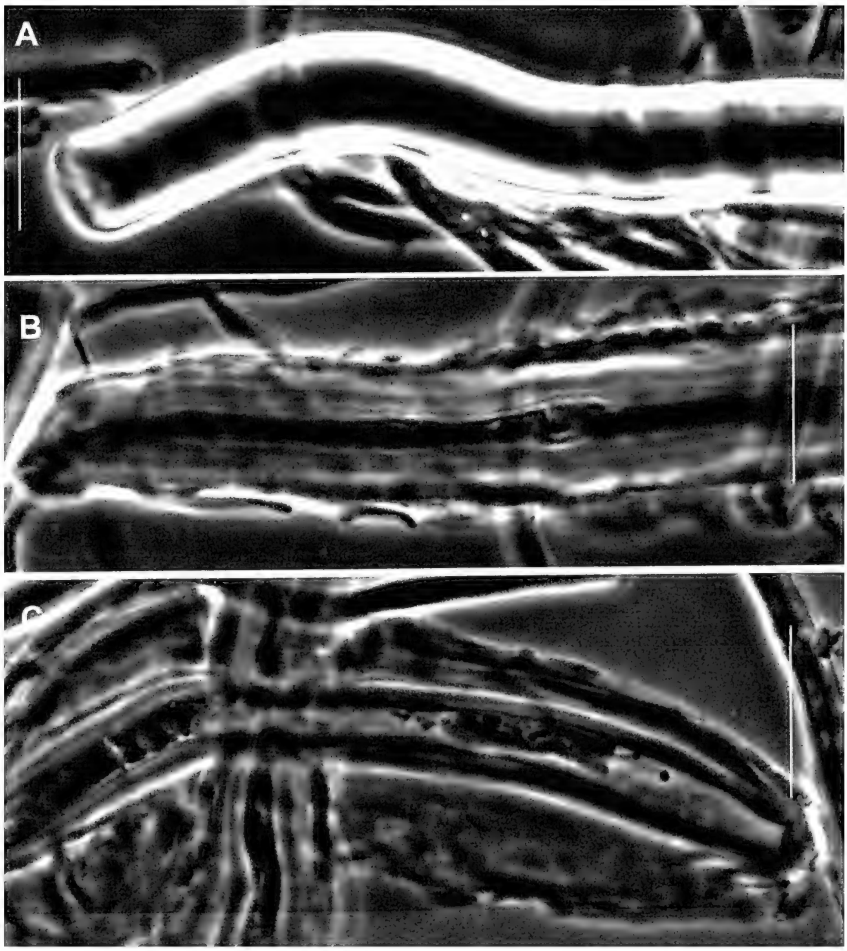

FIG. 30. *Pseudomarasmius nidus-avis* [MES 1477 (FLAS)]. Stout stipe medullary hyphae. A Non-gelatinized hypha. B. Flake-like ornamentation on thin slime sheath. C. Maximum gelatinization. Bars = 10 µm.

ITS sequences from *G. nidus-avis* were intermixed with sequences deposited (by our lab) in GenBank as *Marasmius brevipes*. Independent discovery that voucher collections of these collections of putative *M. brevipes* were clampless confirmed the paraphyletic placement of putative *M. brevipes*. Typical *Marasmius brevipes* (Desjardin & Petersen 1989b) has been transferred to *Gymnopus* (as *G. neobrevipes*; see Petersen & Hughes 2019). Proposal of *G. nidus-avis* including several ITS sequences provides a name for the

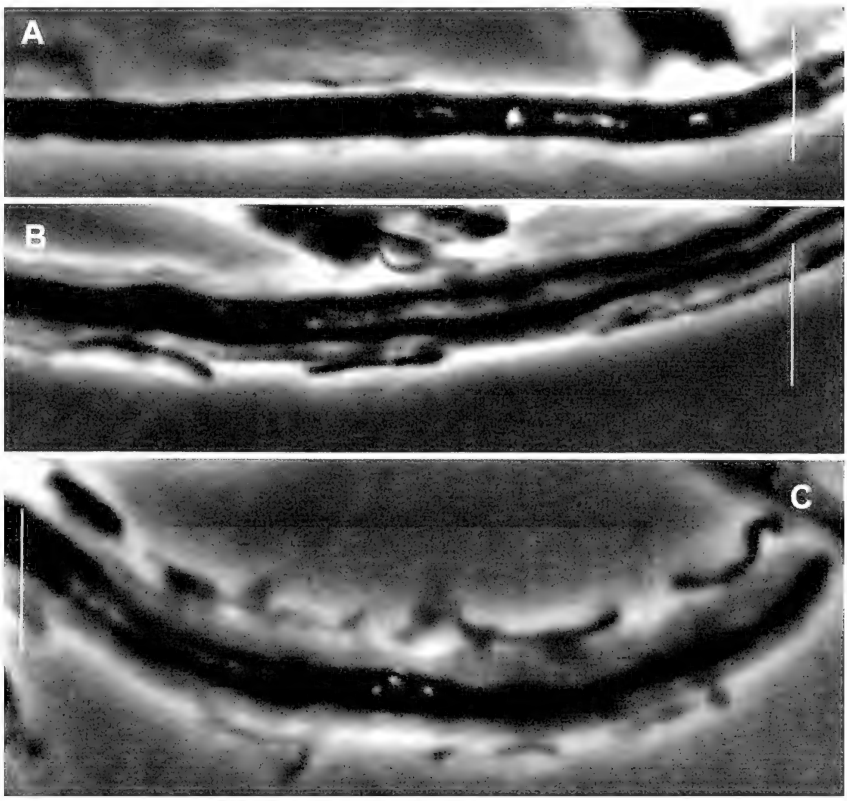

FIG. 31. *Pseudomarasmius nidus-avis* [MES 1477 (FLAS)]. Slender stipe medullary hyphae. A. Non-gelatinized hypha. B. Flake-like ornamentation on thin slime sheath. C. Maximum gelatinization plus ornamentation. Bars = 10 µm.

non-typical collections of putative *M. brevipes*. Inherent is a significantly widened distribution for *G. nidus-avis* from subtropical Mexico to the North American Gulf Coast.

A few specimens at FLAS (variously labelled as unidentified or as "aff. *M. crinis-equi*") lack basidiomata but exhibit rhizomorphs of the *G. nidus-avis* morphology (black, smooth, very slender).

Murrill (1915) proposed *Polymarasmius* for basidiomata which arise as branches of rhizomorphs but noted: "...lamellae adnate to a collar...." *Polymarasmius* was typified by *Marasmius multiceps* Berk. & M.A. Curtis from Cuba, with the other two species from Belize and Jamaica. Such a

diagnosis seems to fit *M. crinis-equi* of *Marasmius* subsect. *Sicciformes,* which is known from the subtropics of the New World.

Specimens consulted: **MEXICO. Veracruz, Municipality of Xalapa**, Santuario del Bosque de Niebla, Instituto de Ecología A.C., 1343 m a.s.l., 18 May 2006, Bandala 4052; 7 July 2016, César 41; 10 Aug 2016, Ramos 682 (all at XAL).

Specimens examined: **UNITED STATES. Alabama, Mobile Co.**, Univ. South Alabama, main campus, VII.2014, coll. unknown, det. J.L. Mata, TFB 14607 (TENN-F-69310). **Florida, Alachua Co.**, Gainesville, Possum Creek Park, 20.IV.2016, coll. M.E. Smith ["On suppressed oak understory, fruiting from elevated branches."] MES1477 (FLAS-F-62667: as *Marasmius "crinis-equi"*); Gainesville, Sweetwater Reserve, 28.VII.18, coll. M.E. Smith, MES3139 (FLAS-F-62668 as *Marasmius "crinis-equi"*); Gainesville, Rock Creek neighborhood, 1.V.2015, coll. M.E. Smith, MES 884 (FLAS-F-62666; as *Marasmius "crinis-equi"*); **Putnam Co.**, Ordway-Swisher Biological Station, near boat ramp of Lake Suggs, 14.VI.2017, coll. R. Healy & al., FLAS-F-60891 as *Marasmius* cf. *brevipes.* **Louisiana, East Feliciana Parish**, St. Francisville, James John Audubon Historic Site, 30°47.84′N 91°18.43′W, 22.V.1997, coll. RHP, TFB 9087 (TENN-F-054912). **Mississippi, Harrison Co.**, Red Creek Wildlife Management Area, 30°40′35″N 88°54′02″W, 11.VII.2014, coll. KWH, TFB 14498 (TENN-F-069189). **Texas, Orange Co.**, Vidor, Virginia Lane, 30°09.24′N 94°00.66W 26.VI.1976, coll. D.P. Lewis, det. D.E. Desjardin (as *M. brevipes*), Lewis 276 (TENN-F-047666).

Pseudomarasmius obscurus R.H. Petersen, **sp. nov.** Figs 32–35

IF 555731

Differs from *Gymnopus pyracanthoides* by its 1) marasmioid basidiomata (stipe slender, black; pileus small, gray, dry); 2) habit on dead, sclerophyllous *Quercus* leaves; 3) copious and obvious resupinate rhizomorphs; and 4) lack of clamp connections.

Type: Costa Rica, Prov. San José, Jardin de Dota, 3.5 km W of Interamerican Highway at El Empalme, 9°4′52″N 83°58′28″W, 15.VI.1995, coll. RHP, TFB 7812 (**Holotype,** TENN-F-053787).

Etymology: Referring to the difficulty in observing microscopic structures.

Basidiomata (Fig. 32a) diminutive, very slender. Pileus 25 mm broad, convex at all ages, becoming essentially applanate with downturned margin by maturity, more or less unicolorous when dry, matte; disc mouse gray; outward to margin "tilleul buff" (7B2), not at all striate, scalloped. Lamellae adnexed to free, thickish, <1 mm broad, seceding in drying to appear pseudocollariate when dried, total lamellae 23–28, through lamellae 13–14, off-white; lamellulae in one rank, often ridge-like. Stipe 11–22 × 0.3–0.6 mm, insititious, terete when fresh becoming channeled on drying, appearing superficially glabrous-shining but under magnification (40×) minutely pruinose upward, apically dark brown, extending into pseudocollarium, very dark brown downward to black-brown lower portion. Rhizomorphs common, often resupinate on leaf surface and there anchored by lateral brownish ciliatiform mycelium,

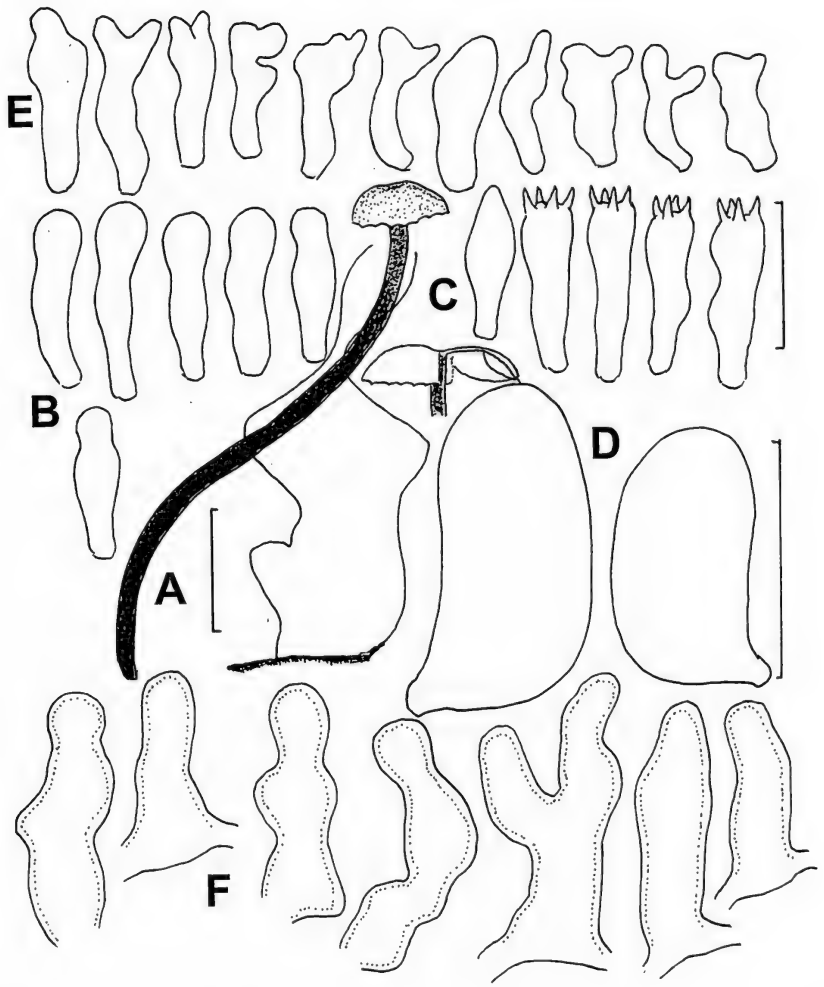

Fig. 32. *Pseudomarasmius obscurus* (TENN-F-053787). A. Basidioma and rhizomorphs with inset showing lamellar attachment. B. Basidioles. C. Pleurocystidium and basidia; D. Basidiospores. E. Cheilocystidia. F. Caulocystidia. Scale bars: A = 5 mm; B,C,E,F. = 20 μm; D = 5 μm.

≤25 mm long where erect, occasionally producing a stellate growth form, very slender (0.1–0.3 mm diam), glabrous-shining, black, curly, frequently branched (similar to those of *G. pyracanthoides*; see Petersen & Hughes 2016).

Distribution & phenology: At present known from a single collection; Costa Rica. Fruiting on sclerophyllous *Quercus* litter with resupinate rhizomorphs; summer.

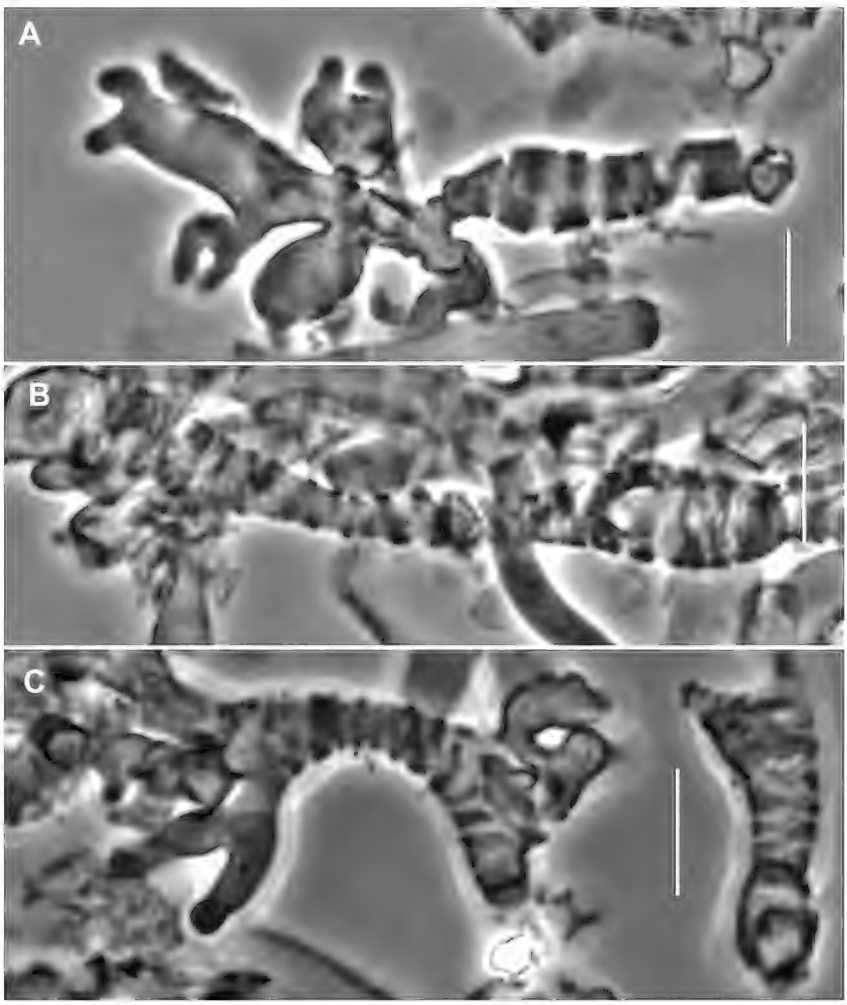

Fig. 33. *Pseudomarasmius obscurus* (TENN-F-053787).
Encrusted hyphae of pileipellis. Scale bar = 10 µm.

Pileipellis composed of two elements: 1) a tangle of free-form, broadly diverticulate hyphae (Fig. 34), 3.5–8 µm diam, thin-walled, variously lobate to subsetulose, often septate, without clamp connections; and 2) strongly encrusted hyphae (Fig. 33) 3–7 µm diam, firm- to thick-walled (wall c. 0.7 µm thick, hyaline); crust material in bands or rings with profile calluses c. 1 µm

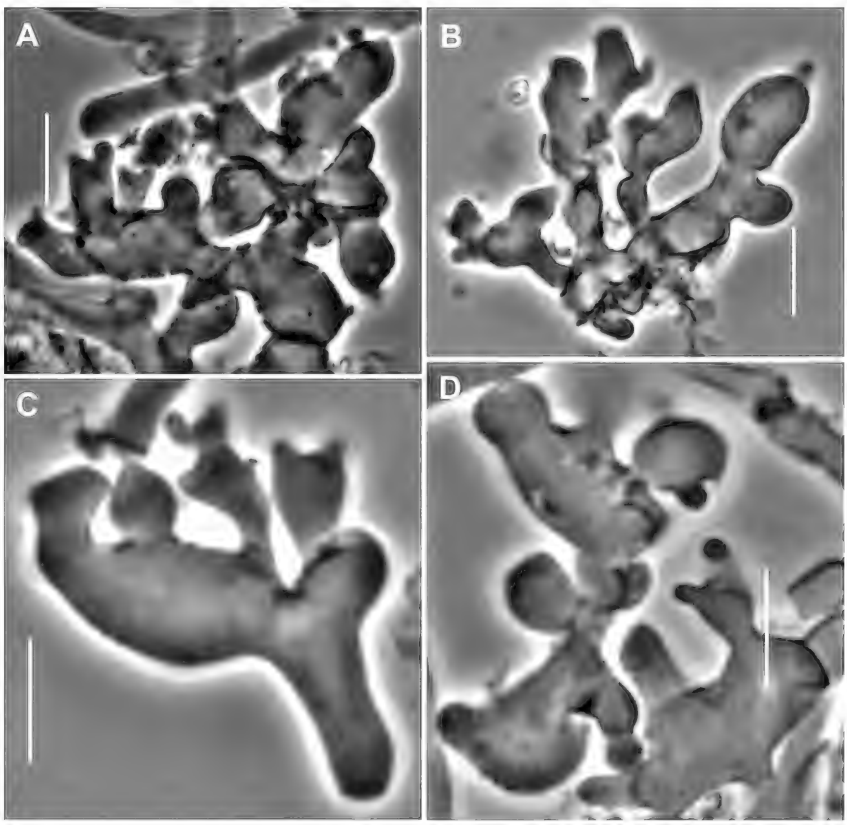

Fig. 34. *Pseudomarasmius obscurus* (TENN-F-037987).
Swollen diverticulate hyphae of pileipellis. Scale bars: 10 μm.

thick. Pleurocystidial structures (Fig. 32c) obscure, 20–28 × 6–8 μm, cylindrical to fusiform, hyaline, thin-walled, without clamp connections. Basidioles (Fig. 32B) clavate to subampulliform; basidia (Fig. 32c) 20–30 × 6–8 μm, clavate to subcapitulate, 4-sterigmate, without clamp connections. Basidiospores (Fig. 32d) 5.5–7 × 3–3.5 μm (Q = 1.71–2.33; Q^m = 1.90; L^m = 6.25 μm), ellipsoid to slightly reniform, variable between tapered proximally and not so, thin-walled, smooth, inamyloid. Cheilocystidia (Fig. 32e) very obscure, 16–25 × 3–8 μm, cylindrical to clavate, often furcate or lobate, thin-walled, hyaline, without clamp connections. Stipe medullary hyphae 4–7 μm diam, thick-walled (wall <1 μm thick, hyaline to weakly

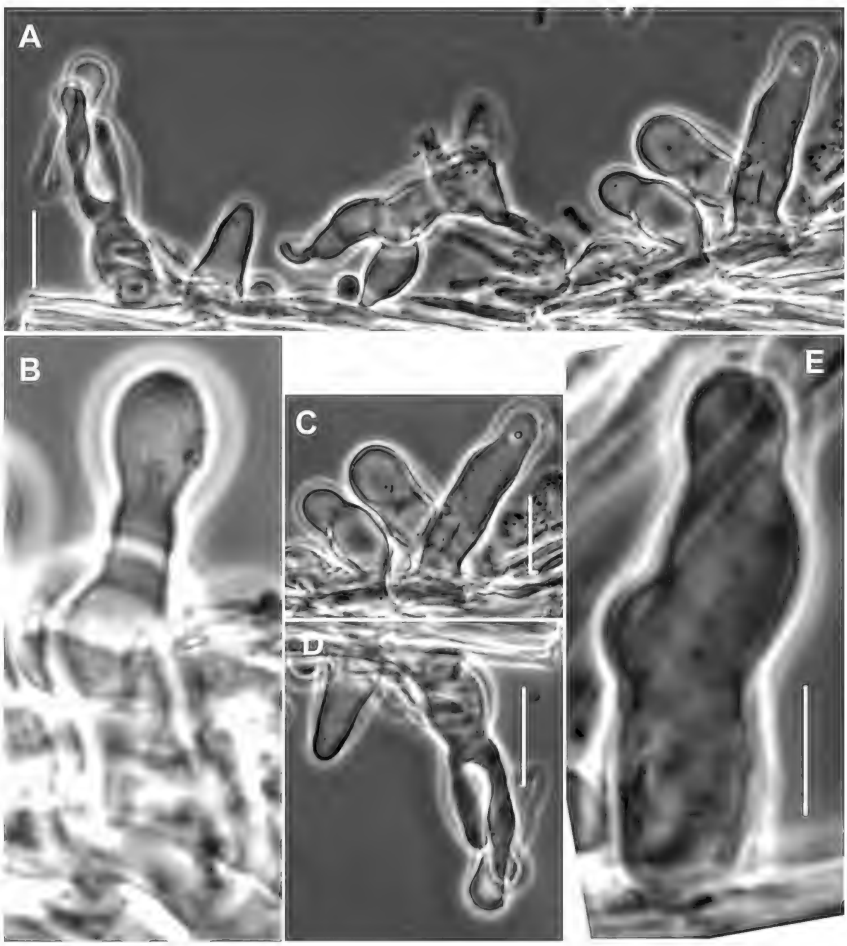

Fig. 35. *Pseudomarasmius obscurus* (TENN-F-053787). Caulocystidia. Scale bars: 10 µm.

pigmented), strictly parallel, with occasional slender, thin-walled, strangulate-digitate to branched hyphae, without clamp connections. Stipe cortical hyphae 3.5–7.5 µm diam, thick-walled (wall often occluding cell lumen), heavily pigmented, distal on stipe producing densely scattered caulocystidia. Caulocystidia (Figs 32F, 35) limited to distal third of stipe, 22–41 × 8–11 µm, variously shaped from pyramidal to furcate to subampulliform, thick-walled (wall <1.0 µm, hyaline), usually with broader base than apex and usually with narrow hyphal origin.

Commentary: Without DNA sequences, accurate placement of TFB 7812 is problematic, but several morphological characters would suggest *Pseudomarasmius*. Production of resupinate rhizomorphs is similar to *G. pyracanthoides* (Petersen & Hughes 2016), also from Costa Rica, also fruiting on *Quercus* leaves and also without clamp connections. The two differ in pileipellis structure (*G. pyracanthoides* pileipellis an intricate thatch of narrow setulose hyphae) and stipe vesture (*G. pyracanthoides* vesture over entire stipe and caulocystidia longer).

Pseudomarasmius pallidocephalus (Gilliam) R.H. Petersen, **comb. nov.** Figs 36–42

IF 555745

≡ *Marasmius pallidocephalus* Gilliam, 1975 Mycologia 67: 818.

Type: United States, Michigan, Chippewa Co., Gilliam 1165 (MICH!, see below).

Diagnostic characters include: Fruiting on dead spruce and fir needles in North America; 2) basidiomata diminutive, exhibiting a white to off-white pileus and off-black, bristle-like stipe; 3) pileipellis with diverticulate hyphae, free-form hyphal segments and broom cell-like hyphal termini; 4) caulocystidia occasional, ampulliform.

Basidiomata (Fig. 36a, 37) diminutive, marasmioid; ratio of stipe length to pileus breadth high (6–8:1). Pileus 5–24(–35) mm broad, pulvinate to convex at first, then plano-convex or broadly conic-convex, finally plane to shallowly concave and often subumbonate or umbilicate, dry or subviscid in wet weather, dull opaque, pliant or membranous, reviving, smooth, subtly sulcate-striate, subtuberculate, even or faintly rugulose-striate to disc, minutely velutinous or matted-fibrillose, dark brown in primordia; disc and inner limb brown (7D4) when young, fading to light brownish grey (6C3), soon light yellowish brown (7.3YR/7.0/2.8 Munsell), brown (7E4) to light brown (7D4) to light greyish brown (7D3) overall, by maturity light grayish yellowish brown, light pinkish yellowish brown, light yellowish pink 7A2 ("light pinkish cinnamon"), pale orange yellow, 6A2 ("pale pinkish buff"), light yellowish brown 6B5, 7,3YR/7,0/2.8 (Munsell) ("cinnamon"), dark brown (Maerz & Paul 16A12) moderate 4.7Y/5.2/4.1 (Munsell) yellowish brown, fading to greyish orange (6B2); drying about 5A5 ("ochraceous buff"); outer limb and margin yellowish, at first entire, soon eroded or crenate, white (Maerz & Paul 9B2), pale orange yellow 6A2 ("pale pinkish buff"), 4D2 pale yellowish white to off-white to 7B2 ("tilleul buff"), smooth, brownish grey when young, becoming minutely rugulose-striate, buff in age – overall pallid coloration in age. Pileus trama thin, yellowish white (5.5Y/9.3/1.8 Munsell) to light yellowish brown (7.3YR/7.0/2.8 Munsell).

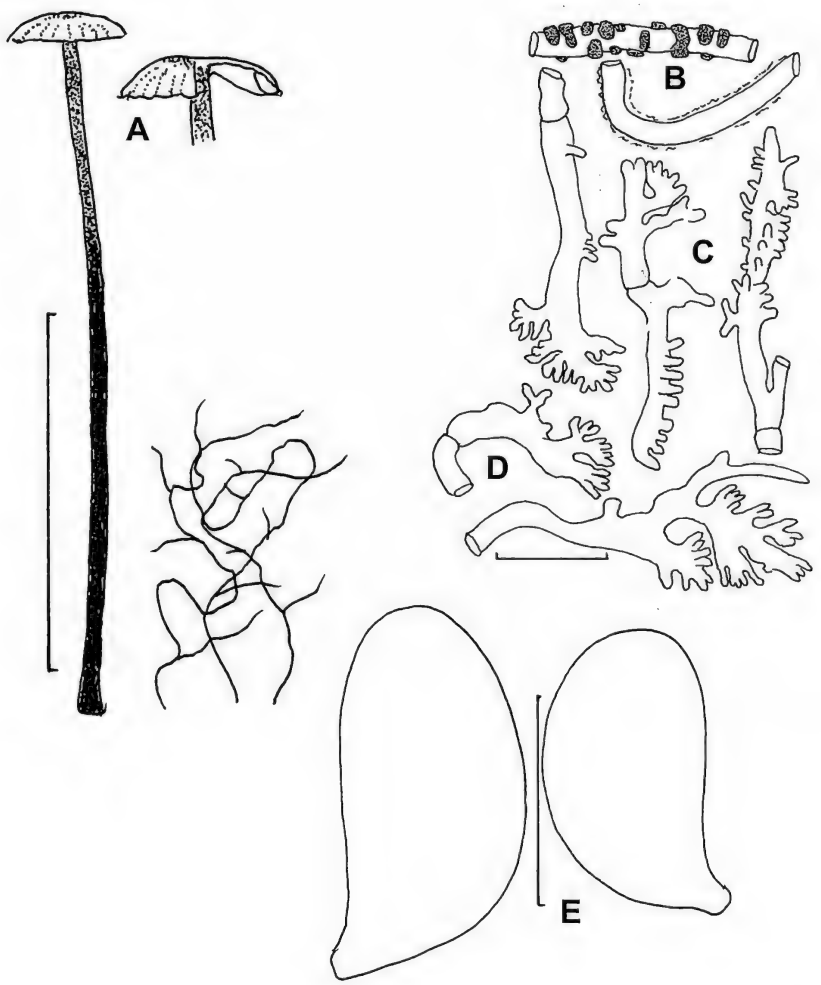

Fig. 36. *Pseudomarasmius pallidocephalus* (TENN-F-063098). A. Basidioma and rhizomorphs. B–D. Pileipellis elements. B. Encrusted hyphal segment and hypha with slime sheath. C. Diverticulate hyphae. D. Diverticulate hyphal termini. E. Basidiospores. Scale bars: A = 20 mm. B–D. = 10 µm. E = 5 µm.

Lamellae narrow (c. 1 mm broad), thin, subdistant, total lamellae = 32–37, through lamellae = 15–17, unequal, adnate at first, becoming adnexed or free to sinuate in age, or sometimes attached to a partial adnate collar, seceding upon drying, pliant, entire or minutely fimbriate, thickish, narrow, straight at first, broader near the stipe in age, not intervenose or obscurely so in age,

FIG. 37. *Pseudomarasmius pallidocephalus*. Basidiomata. A. Photo from nature (TENN-F-066344). Courtesy Steve Trudell. B. Field-dried basidiomata (TENN-F-052401). Scale bars: 10 mm.

not forked, off-white at first, yellowish white (5.5Y/9.3/1.8 Munsell), pale orange yellow 3A2 ("light buff"), or light yellowish brown (7.3YR/7.0/2.8

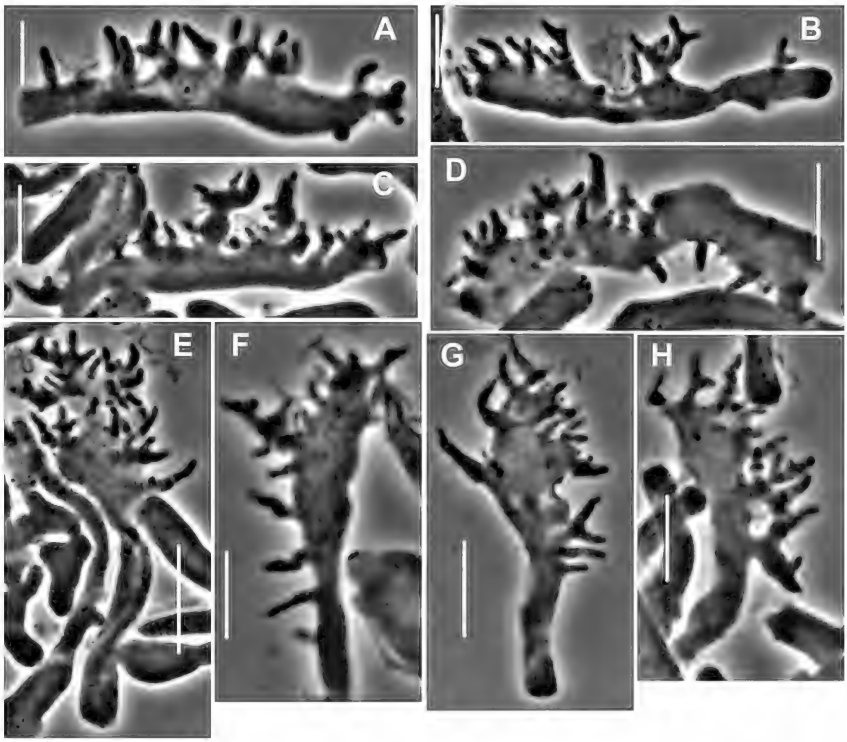

Fig. 38. *Pseudomarasmius pallidocephalus* (TENN-F-020486). Pileipellis elements. A–D. Repent, diverticulate hyphae. E–H. Broom cell-like, diverticulate hyphal termini. Scale bars: 10 μm.

Munsell), soon buff to pale greyish (5A2), buff to pale orange grey (<5B2), soon buff to pale greyish (<5A2), 6A2 ("pale pinkish cinnamon"), ca. 5A4 ("light ochraceous buff"), in age mellowing to 9B2 ("vinaceous buff"), to 6A2 ("pale pinkish cinnamon"), when dried buff to pale orange grey (<5B2); lamellulae in 12 tiers. Stipe 1243 × 0.20.8 mm thick, insititious, central or somewhat eccentric, terete, equal or tapering downward, straight when moist, soon curling and twisting on drying, shining, opaque, hollow, bristle-like but not tough (thin, stiff and easily cut), equal or tapering slightly downward, glabrous; apical 12 mm sometimes whitish-pruinose, more or less concolorous with lamellae ("ochraceous buff"), downward light yellowish brown (7.3YR/7.0/2.8 Munsell) to moderate yellow brown (0.7Y/5.2/4.1 Munsell) or dark reddish brown (10.0R/1.5/1.5 Munsell) to dark brown on the upper half, downward black-brown, brownish grey

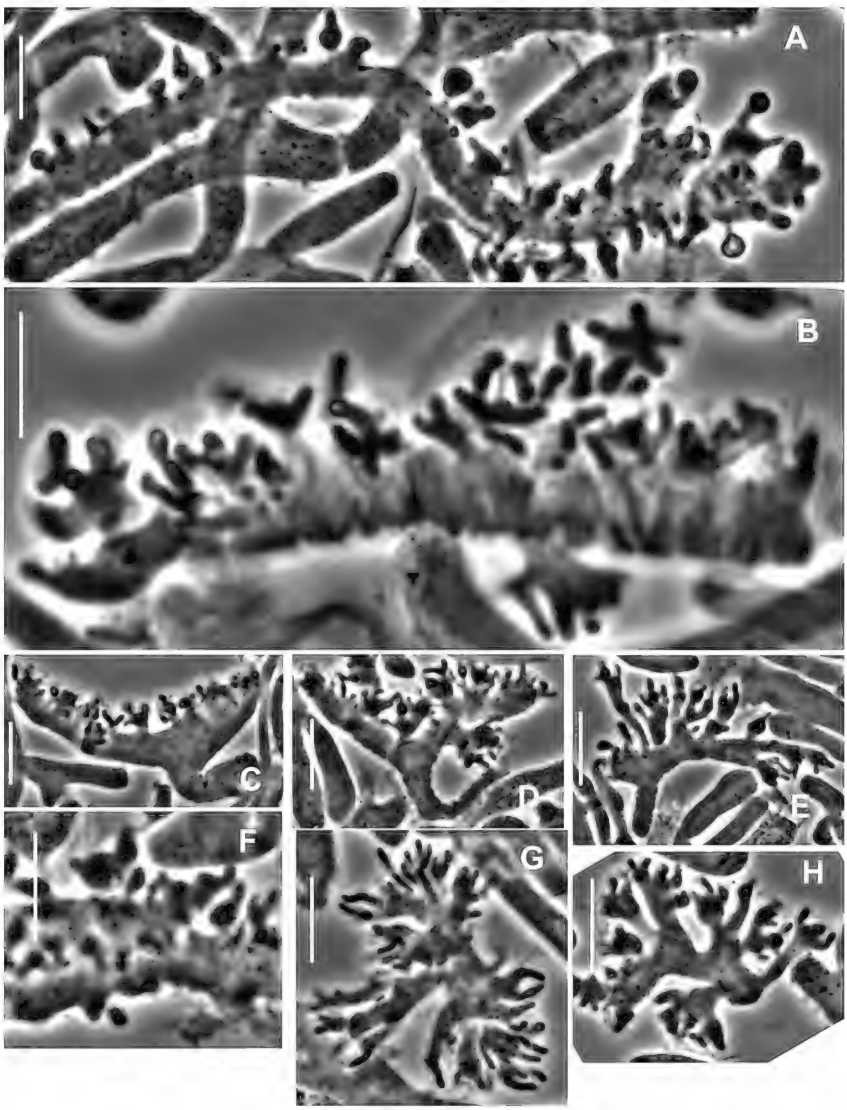

FIG. 39. *Pseudomarasmius pallidocephalus* (MICH 51323). Pileipellis elements. A,B. Repent diverticulate hyphae. C–H. Broom cell-like, diverticulate hyphal termini. Note frequency of di- or trichotomously branched diverticula. Scale bars: 10 µm.

(6C3) to greyish brown (7D3), soon dark brown (7F4-8), 5F8 ("bister"), 6F4 ("fuscous black"), 7F8 ("bone brown"), olive-brown [6E4 ("fuscous"), 2F3

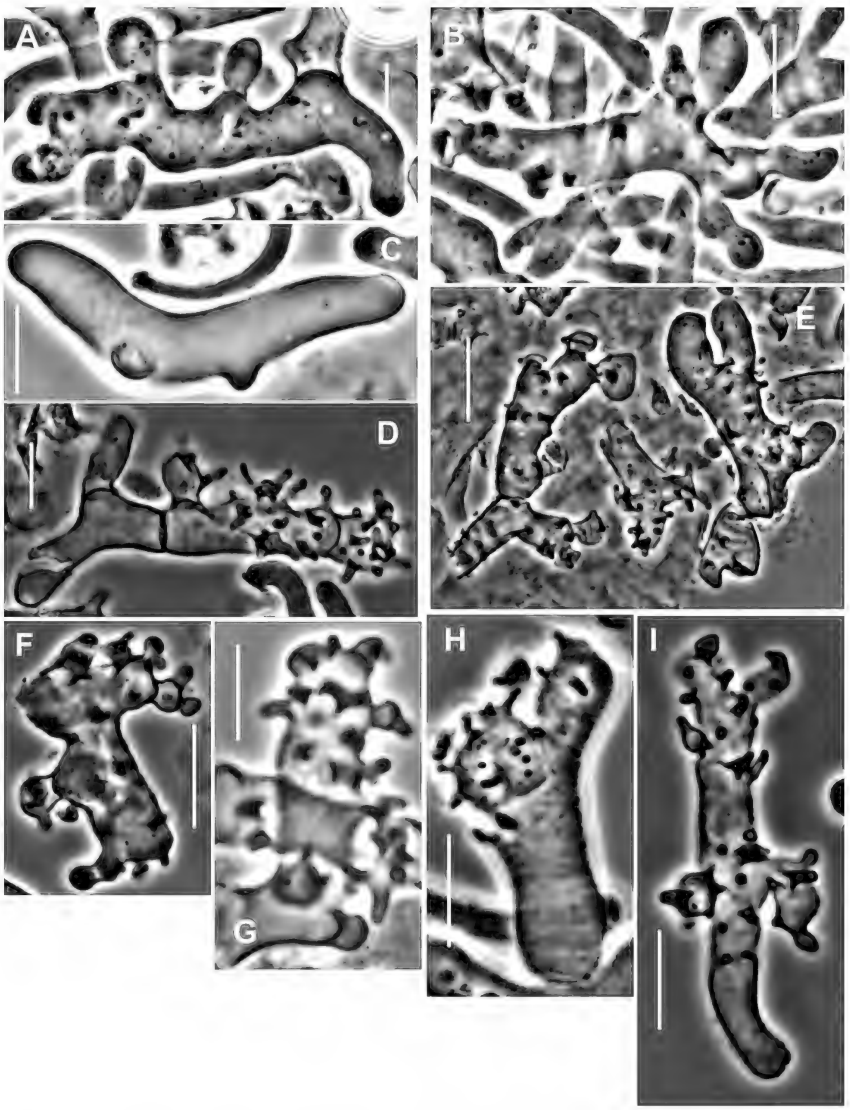

Fig. 40. *Pseudomarasmius pallidocephalus* (WTU-F-8911). Free-form pileipellis elements. A–C. Non-diverticulate individuals. D–I. Diverticulate individuals. Scale bars: 10 µm.

("chaetura black")], never black downward; when dried glabrous-shining, delicately ridged, compressed; basal mycelium absent; sterile stipes absent. Rhizomorphs (Fig. 36a) ≤17 × 0.1–0.5 mm, slender, hair-like, scarce to

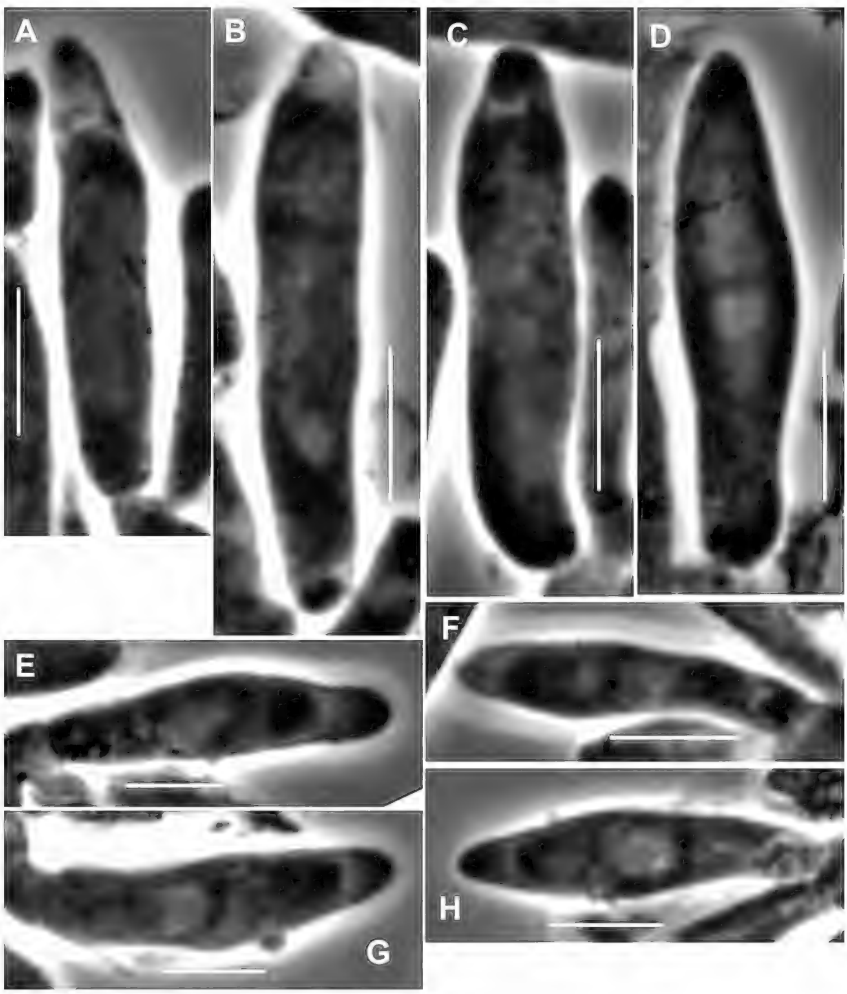

FIG. 41. *Pseudomarasmius pallidocephalus*.
Pleurocystidia (A–D. MICH 51323. E–H. TENN-F-026266).
Note frequent distal, vague partition of contents. Scale bars: 10 μm.

abundant, arising at intervals along the substrate, much branched with spur-branches often long and flagelliform, twisted and curled, sometimes forming a loose tangle. ODOR negligible; TASTE negligible.

HABITAT & PHENOLOGY: Occasional to common in troops on needles and debris of conifers, chiefly *Picea* and *Abies* in spruce-fir forest, rarely on *Thuja* debris: highest elevation of southern Appalachian Mountains, north through

New England into and across the continent to the Pacific Coast temperate rain forest and there accompanied by *Pseudotsuga menziesii*, *Arbutus menziesii*, *Quercus garryana*, *Acer macrophyllum*, and occasionally *Thuja plicata*, with understory of *Alnus*, *Salix*, *Shepherdia;* apparently a mid-summer fungus.

Pileipellis composed of the following elements embedded in a thin slime matrix: 1) repent hyphae 3–7.5 µm diam, firm- to thick-walled (wall c. 0.5 µm thick), hyaline individually, yellowish in mass, coarsely ornamented variously from stripes with plate-like profile calluses to flake-like with the flakes very slightly separated from the hyphal outer wall as though with a very thin slime layer between; 2) scattered free-form hyphal segments (Fig. 40) as in a "*dryophila*-structure," but not articulated into a cutis; 3) repent hyphae (Figs 36b–d, 38a–d, 39) 4–40 × 4–10 µm, inflated somewhat, with diverticulate, papillate to digitate (often forked) processes, 2–6 × 0.7–3 µm at base, not thick-walled, sub-refringent, sometimes in pairs or dichotomously branched (i.e. "saddle-shaped"), distributed more or less randomly (not unilateral); and 4) broom cell-like termini (Figs 36c, d, 38e–h, 39c–h, 40d–i) usually arising from lightly encrusted hyphae, stalked (stalk 15–25 × 3.5–5.5 µm), thin-walled, often branched dichotomously and then often divaricate, beset by numerous diverticula; diverticula lobate to conical and sometimes with a combination of forms; clamp connections absent. Pileus trama loosely interwoven; hyphae 4.5–13 µm diam, firm-walled, without clamp connections, involved in minimal individual slime sheath but not coherent in tissues, occasionally coarsely ornamented with annular incrustation ≤2 µm thick, often ornamented with vague, poorly defined stripes. Lamellar trama loosely interwoven; hyphae 2.5–8(–13) µm diam, firm- to thick-walled (wall c. 0.5 µm thick, hyaline), involved in minimal individual slime sheath but not coherent in tissues, occasionally coarsely ornamented with annular incrustation ≤2 µm thick, often ornamented with vague, poorly defined stripes, easily disarticulated; clamp connections absent. Pleurocystidia (Fig. 41) 23–33 × 5–8 µm, narrowly fusiform to fusiform with narrowing rounded apex, usually without content partition, without clamp connections; contents homogeneous but with vague central vacuolated area (PhC). Basidioles clavate-subcapitate, clampless; contents vaguely multigranular; basidia (Fig. 42a–d) (20–)25–34 × (4–)5–8(–10) µm, clavate, (2)4-sterigmate, without clamp connections; contents multigranular. Basidiospores (Fig. 36e) (5–)5.5–7(–9.5) × 3–3.5(–6) µm (Q = 1.30–2.33; Q^m = 1.87; L^m = 6.7 µm), ellipsoid to plump ellipsoid to elongate pip-shaped, flattened adaxially, not tapered proximally, thin-walled, smooth, inamyloid;

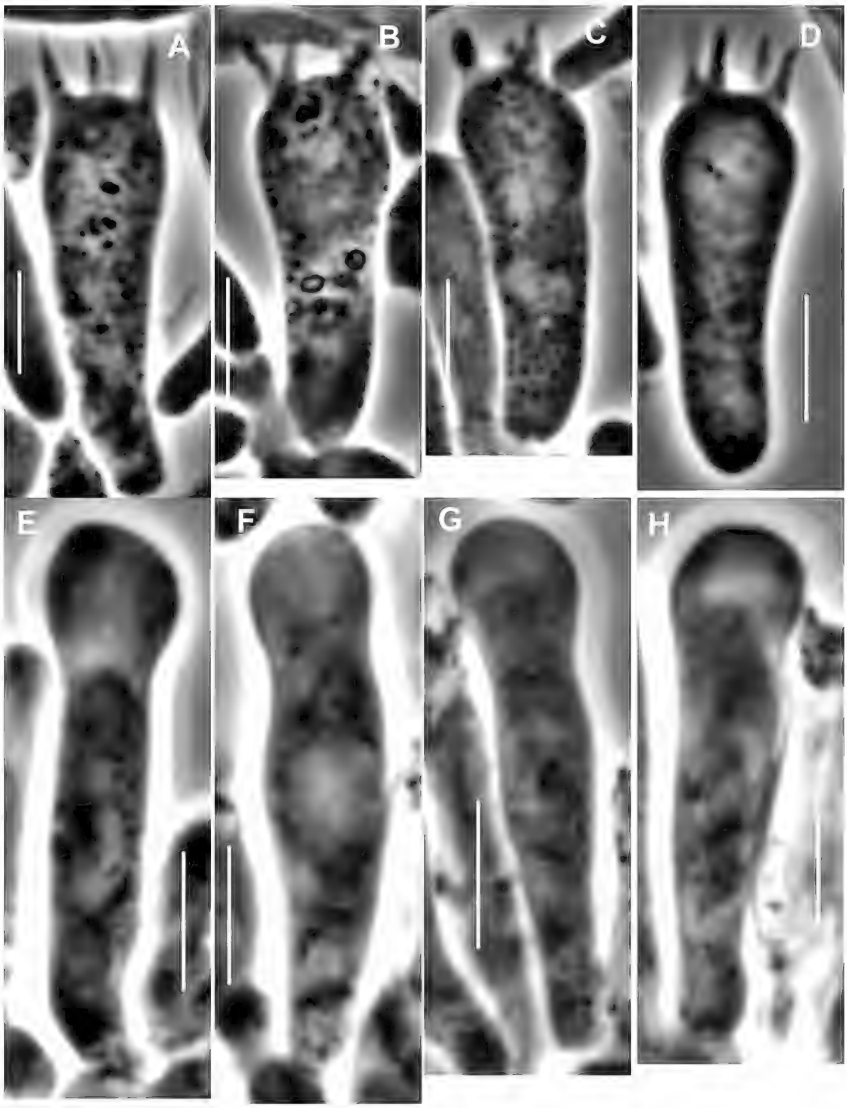

Fig. 42. *Pseudomarasmius pallidocephalus*. Hymenial structures.
A–D. Basidia (MICH 51323). E–H. Cheilocystidia (TENN-F-026266).
Scale bars: 10 μm.

contents homogeneous. Cheilocystidia (Fig. 42e–h) scattered, similar to basidioles, 21–30 × 5–8.5 μm, clavate at first, becoming ampulliform by maturity, without clamp connections. Stipe medullary hyphae (Fig. 43)

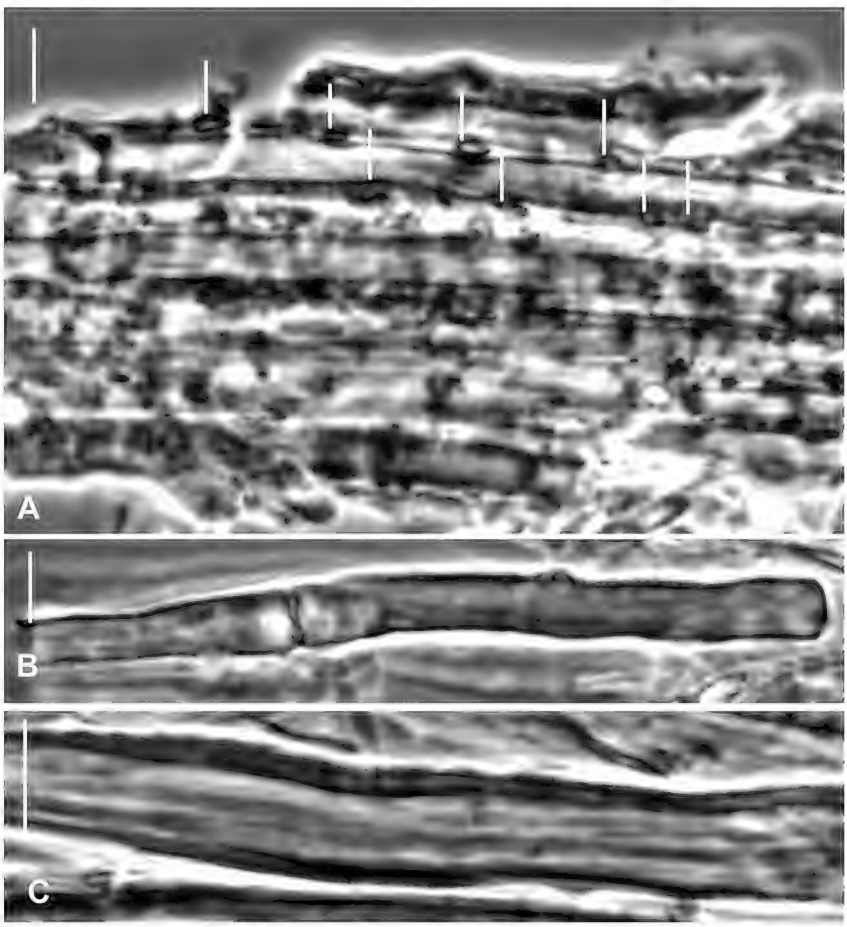

Fig. 43. *Pseudomarasmius pallidocephalus* (TENN-F-056761). Stipe medullary hyphae. A. Outer hyphae, with lines marking hyphal crust depositions. Stipe surface upward in photo. B, C. Individual inner medullary hyphae. B. Notes septum without clamp connection. C. Note wall thickness. Scale bars: 10 μm.

(inner) (2–)3.5–8.5 μm diam, strictly parallel, firm- to thick-walled (wall ≤1.2 μm thick, hyaline), coherent in tissues (i.e. minimal slime matrix), lacking clamp connections; outer medullary hyphae 1–3.5(–7.5) μm, firm- to thick-walled (wall <1 μm thick, hyaline, ornamented with lens-shaped encrustation often appearing pitted). Stipe cortical hyphae moderately to strongly dextrinoid, 3–5.5 μm diam, thick-walled (wall often occluding cell lumen), smooth or covered with heterogeneous slime with inclusions.

COMMENTARY: *Pseudomarasmius pallidocephalus* combines characters seen in other related complexes. Basidiome stature, size, rhizomorphs, and habitat all mimic (or are mimicked by) *Gymnopus* sect. *Androsacei* and/or *G.* sect. *Perforantia*. The minimal slime matrix of the pileipellis and stipe medullary hyphae resemble those of *Gymnopus* sect. *Perforantia*, while dextrinoid stipe cortical tissue is like that of some members of /marasmiellus (ss Wilson & Desjardin (2005). The diverticulate hyphae of pileipellis resemble those of *Mycetinis* (including the inflated cells typical of that genus), not those of *Marasmius* (*siccus*-type) and the free-form hyphal segments of pileipellis are similar to such structures in *Gymnopus* sect. *Levipedes* ("*dryophilus*-structure"). Lack of clamp connections, however, seems quite unusual in related complexes. Several taxa in *Gymnopus* sect. *Androsacei* have been described as clampless, mostly by Singer, and they generally have been found in New- and Old-World tropical forests and none with accompanying molecular phylogenies.

Desjardin (1989) reported *Ps.* (as *Marasmius*) *pallidocephalus* as "one of the more commonly collected, early-fruiting litter-decomposing agarics in the spruce-fir zone of the southern Appalachians." In these spruce-fir forests, it has been and is easily misidentified as *G.* (as *Micromphale*) *perforans*, which usually exhibits a pigmented pileus toward cinnamon or avellaneous and vestured stipe. *Gymnopus androsaceus* is encountered only occasionally.

Pleurocystidia in *P. pallidocephalus* are typical of such structures found widely through gymnopoid/marasmioid fungi. Such structures are fusiform in shape, with narrowly rounded apex, as opposed to clavate to subcapitulate shapes of basidioles. Apparently without taxonomic relevance, pleurocystidial shapes are sometimes accompanied by vaguely partitioned contents. In *Ps. pallidocephalus*, however, such structures are often more broadly rounded apically. Basidioles and basidia, conversely seem to be consistently clavate from an early stage, and with heterogeneous contents (FIG. 42A–D), unlike pleurocystidial structures which remain homogeneous in content. In numerous descriptions (including our publications up to a couple years ago) the structures termed here as pleurocystidia were included under the perceived variability of basidioles.

Gilliam (1975) mentioned clamp connections only once, under pileus tramal hyphae. This observation was erroneous: clamp connections are consistently absent on all basidiomatal hyphae in *Ps. pallidocephalus*. Desjardin (1990) examined cultures of *Ps. pallidocephalus* and reported the absence of clamp connections.

Past experience (Petersen 1978, Petersen & Hughes 2010) has produced some links between absence of clamp connections, 2-spored basidia, and oversize basidiospores indicative of haploid state, together with unexplained sexual compatibility systems. These links seem irrelevant in *Ps. pallidocephalus*, where basidiomata lacking clamp connections normally produce 4-spored basidia. The mating system of this species remains unknown.

Gilliam (1975) seemed intent on separating *Ps.* (as *Marasmius*) *pallidocephalus* from *M. androsaceus,* the often-reported taxon which fruits on similar substrates in Europe and North America. Her concept of *M. androsaceus* was revealed in the concluding lines of her discussion, as fruiting on a "variety of habitats." Not only is this observation understandable given the state of prior literature and the date of her study, but it may have influenced Desjardin's (1989) treatment of *M. androsaceus* in his dissertation, which also drew no attention to clamp connections. Currently, phylogenies indicate that *M. androsaceus* may be split into at least three species: *M. androsaceus* fruiting on conifer debris, plus two which fruit on dead deciduous leaves (Petersen & Hughes, ined.). Other mimics fruit on pine needles [*Gymnopus* (*Micromphale*) *pinophilus* complex; Petersen & Hughes 2016a], cedar twigs and redwood litter [*Gymnopus* (*Micromphale) sequoiae* complex]. In addition to presence/absence of clamp connections, *Ps. pallidocephalus* lacks conspicuous cheilocystidia [only a few ampulliform shapes reminiscent of those of *G. trabzonensis* (Vizzini & al. 2015)] while *G. androsaceus* exhibits common cheilocystidial structures. Finally, Gilliam (1975) reported the lack of "hymenial cystidia" (inclusive of pleuro- and cheilocystidia) in *M. pallidocephalus*, perhaps because pleurocystidia are not conspicuous. Our experience with other taxa indicates that pleurocystidial structures are present.

Rhizomorph presence and activity are arcane in *Ps. pallidocephalus*. Basidiomata are usually formed on dead needles from the previous 1–2 years, but the needle bed on which they are found is usually deeper, with more decayed needles (differing in color and substance) and these decayed needles are held together by tangles of slender, branched, black rhizomorphs. Rhizomorphs at the surface of the needle bed, and therefore accompanying basidiomata, are usually individual, extremely slender, short, and therefore easily overlooked.

Examination of numerous marasmioid specimens from Europe has not revealed a single specimen of *Ps. pallidocephalus*.

Specimens examined: **CANADA, British Columbia, Cariboo Regional District,** Ft. St. James, 54°26′34″N 124°15′04″W, 13.VII.1940, coll. T.T. McCabe, det. J.W. Groves (as *M. androsaceus*), TTM 253 (UC 1319403); **Stikine Region,** Liard River Hotsprings Prov. Park, 59°25′06″N 126°05′27″W, 18.VIII.2000, coll. R. Winder, O. Ceska, det. O. Ceska (as *M. androsaceus*) (UBC F21036); **Metro Vancouver Regional District,** Mt. Seymour Prov. Park, base of chair lift, 49°22′51″N 122°56′24″W, 27.VIII.1973, coll. S.A. Redhead (as *M. androsaceus*) (UBC F8178); **Capital Regional District,**, Saanich Peninsula, Observatory Hill, 48°31′44″N 123°25′19″W, 17.X.2008, coll. O. Ceska (as *M. androsaceus*) (UBC F29843); Observatory Hill, 48°31′44″N 123°25′19″W, 17.X.2008, coll. O. Ceska (as *M. androsaceus*) (UBC F29843); Observatory Hill, 48°51.67′N 123°42.20′W, 28.II.2010, coll. & det. O. Ceska (as *M. androsaceus*), UBC-F24293; **Fraser Valley Regional District,** Manning Prov. Park, Rhododendron Flats, 49°13′N 121°04′W, 11.VI.2006, coll. Paul Kroeger (as *M. androsaceus*), PK 4072 (UBC F17578). **UNITED STATES, Alaska, Fairbanks,** Fairbanks North Star, Ballane Lake Marge, 64°54.82′N 147°42.31′W, 15.VII.2006, coll. G.A. Laursen [as *Marasmius androsaceus*], GAL 19442a (WTU-F-31851). **Idaho, Bonner Co.,** Priest Lake, Luby Bay, 48°32′50″N 116°55′24″W, 25.IX.1992, coll. RHP (as *M. androsaceus*), TFB 5632 (TENN 52407); **Shoshone Co.,** vic. Wallace, Coeur d'Alene Nat. Forest., 47°30′N 115°53′W, 24.IX.1992, coll. RHP (as *M. androsaceus*), TFB 5610 (TENN 52401); **Maine, Hancock Co.,** rte 182, vic. Mud Pond and Salmon Pond, 44°37′58″N 68°05′14″W, 21.VII.1992, coll. S.A. Gordon, TFB 4987 (TENN 56761). **Michigan, Cheboygan Co.,** vic. Univ. Michigan Biological Station, Hermit Swamp, 45°33′31″N 84°40′43″W, 26.VI.1957, coll. R.L. Shaffer (as *M.* cfr. *androsaceus*), RLS 1291 (MICH 51323); **Chippewa Co.,** Tahquamenon Falls State Park, Lower Falls, 46°36′16″N 85°12′11″W, 22.VII.1971, coll. & det. M. Gilliam (HOLOTYPE), MSG 1165 (MICH 11402, portion only); **Marquette Co.,** Pine Plains, W of Michigamme State Forest, "Triple A" road, 46°31′14″N 88°03′14″W, 15.VII.1970, coll. J.F. Ammirati & S.J. Mazzer, det. M. Gilliam (as *M. pallidocephalus*), SJM 4479 (MICH 51322). **Minnesota, Clearwater Co.,** Itasca State Park, 9.VIII.1968, coll. M.G. Weaver (as *Marasmius* sp.), det. M. Gilliam (as *M. pallidocephalus*), MGW 1621 (MICH 175913). **New York, Franklin Co.,** Paul Smith's, NEMF pre-foray trip no. 1, Hazel Pond Rd., 44°28.89′N 74°16.50′W, 11.VIII.2011, coll. A.S. Methven, TFB 13933 (TENN 65829); **North Carolina, Swain Co.,** vic. Bryson City, GSMNP, Spruce-Fir Nature Trail, 35°34′02″N 83°28′54″W, 28.VIII.2009, coll. RHP (as *M. androsaceus*), TFB 13664 (TENN 63098); 8.VI.1991, coll. S.A. Gordon, TFB 3623 (TENN 50742); 28.VIII.2009, coll. RHP, TFB 13664 (TENN 63098); vic. Bryson City, GSMNP, Clingman's Dome, 35°33′40″N 83°29′45″W, 10.IX.1985, coll. D.E. Desjardin, DED 3412 (TENN 54660); 35°33′47″N 83°29′55″W, 27.IV.1954, coll. A.H. Smith & L.R. Hesler (TENN 021343). **Tennessee, Blount Co.,** GSMNP, Appalachian Trail vic Clingman's Dome, near old Indian Gap road, 28.V.2011, coll. Steve Trudell, SAT-11-11-179-05 (TENN 66344); **Sevier Co.,** GSMNP, Indian Gap, Appalachian Trail, 35°36′35″N 83°26′19″W, 29.V.2004, coll. RHP (as *M. androsaceus*), TFB 11778 (TENN 59896); 36°36′35″N 83°26′19″W, 13.VII.2004, coll. S.C. McCleneghan & E.B. Lickey, TFB 11970 (TENN 59975); Old Indian Gap Road, 28.VI.1986, coll. D.E. Desjardin, DED 3691 (TENN 54667); 19.VII.1988, coll. D.E. Desjardin, DED 4615 (TENN 54650); 11.VI.1986, coll. D.E. Desjardin, DED 3581 (TENN 54646); **Washington, Jefferson Co.,** Olympic

National Park, Enchanted Valley, 47.6675°N 123.3939°W, coll. J.W. Lennox (as *M. androsaceus*), JWL 511 (WTU-F-8911); **Lewis Co.**, Skate Creek Rd., between Horse Creek and milepost 17, 2.X.1993, coll. RHP (as *M. androsaceus*), TFB 5698 (TENN 53475).

Pseudomarasmius patagonianus R.H. Petersen, **sp. nov.** FIGS 44–48

IF 555733

Differs from *Pseudomarasmius nidus-avis* by its 1) slender rhizomorphs that are present but not dominant; 2) basidiomata arising as branches of rhizomorphs or from rotting leaves; 3) pileipellis elements usually semi-gelatinized; and 4) distribution in southern South America (Chilé).

TYPE: Chilé, Chiloé, Isla Grande de Chiloé, Ancud, 41°52′18″S 73°49′06″W, 9.V.1995, coll. RHP, TFB 7363 (**Holotype,** TENN-F-054432).

ETYMOLOGY: Referring to the Patagonian origin of the collections.

BASIDIOMATA (FIG. 44A) marasmielloid, short-stipitate, similar to those of *Ps. nidus-avis*. PILEUS ≤11 mm broad, campanulate with downturned margin becoming more or less applanate, often abruptly umbilicate, subtly striate, somewhat pulvinate, matte, from uniformly 6C6 ("tawny") to disc 6B5 ("cinnamon") when young, paler in age; outward "pinkish buff" (6A3) to off-white. LAMELLAE adnate to shortly decurrent, distant, ranging from well-defined to reduced, usually as shallow (<1 mm broad) pleats, ≤20 total folds, 5–8 through folds, 5A2 ("pale cinnamon pink") to off-white (now 4A2 "pale ochraceous buff"). STIPE 2–8 × 1.5–2.5 mm, terete, equal, straight to usually strongly curved, black, upward glabrous shining, downward minutely pruinose, non-insititious with minimal basal tuft. RHIZOMORPHS rare, slender, black, of unknown length. ODOR and TASTE negligible.

HABITAT & PHENOLOGY: A poorly understood taxon, erumpent on woody substrate, noted as "on hardwood boughs;" Chilean winter.

PILEIPELLIS comprising the following: 1) at pileus margin, repent diverticulate hyphae 2.5–5.5 µm diam, firm-walled, not gelatinized, hyaline; diverticula stout, ≤7 × 1–2.5 µm at base, gnarled-pyramidal, often dichotomous; 2) at pileus margin, diverticulate hyphal termini (hardly broom cell-like) (FIG. 45), resembling repent diverticulate hyphae, perhaps sometimes erect; 3) over disc and limb, occasional pileal hairs ≤75 × 3–4.5 µm, cylindrical, subtly capitulate, arising as an erect branch of the repent hypha; 4) unorganized hyphae 3–6.5 µm diam, thin-walled, variously ornamented (FIG. 46) with crust material often coarsely in scabs <2 µm thick (FIG. 46B), often appearing annular (FIG. 46A,C), easily disarticulated; 5) hyphae 2.5–4.5 µm, not easily crushed, thick-walled (wall ≤0.7 µm thick),

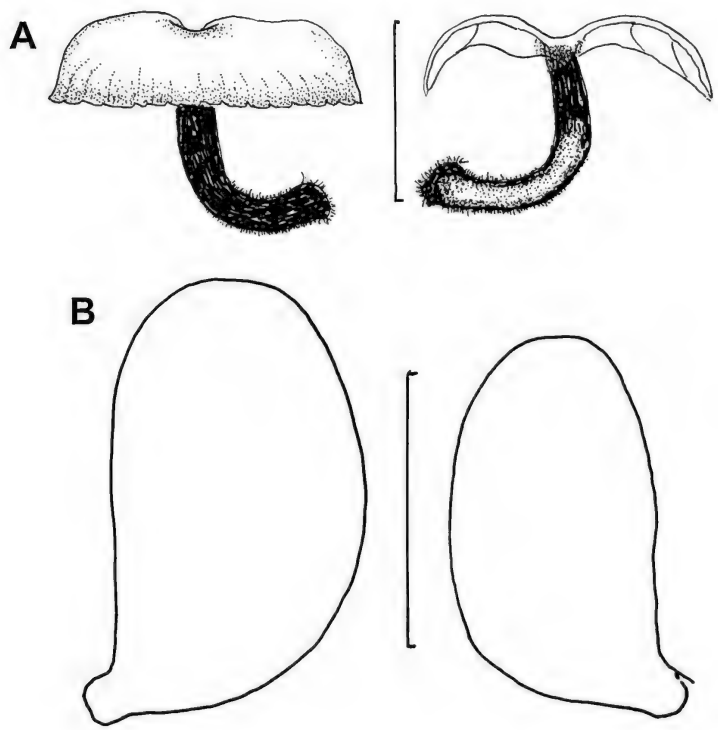

Fig. 44. *Pseudomarasmius patagonianus* (TENN-F-054432, holotype).
A. Basidiomata (left) habit; (right) longitudinal section.
B. Basidiospores. Scale bars: A = 5 mm; B = 5 µm. TFB 7363

often with thin individual slime sheath with flake-like ornamentation (Fig. 46d). Diverticulate hyphae or hyphal termini not observed over disc or limb. Lamellar trama loosely interwoven; hyphae 2–5.5 µm diam, firm- to thick-walled (wall ≤1 µm thick), often gelatinizing or with individual thin slime sheath, without clamp connections. Pleurocystidia (Fig. 47) uncommon or poorly defined, 22–25 × 5–6 µm, fusiform, without clamp connections. Basidia (Fig. 48) 28–37 ×10–12 µm, clavate, (2–)4-sterigmate, without clamp connections; contents heterogeneous when mature, emptying but not collapsing ("husking") when effete. Basidiospores (Fig.44b) 9–9.5 × 4–5 µm (Q = 1.60–2.25; E^m = 2.07), ellipsoid, thin-walled, not tapered proximally, inamyloid. Cheilocystidia absent or undifferentiated. Stipe medullary

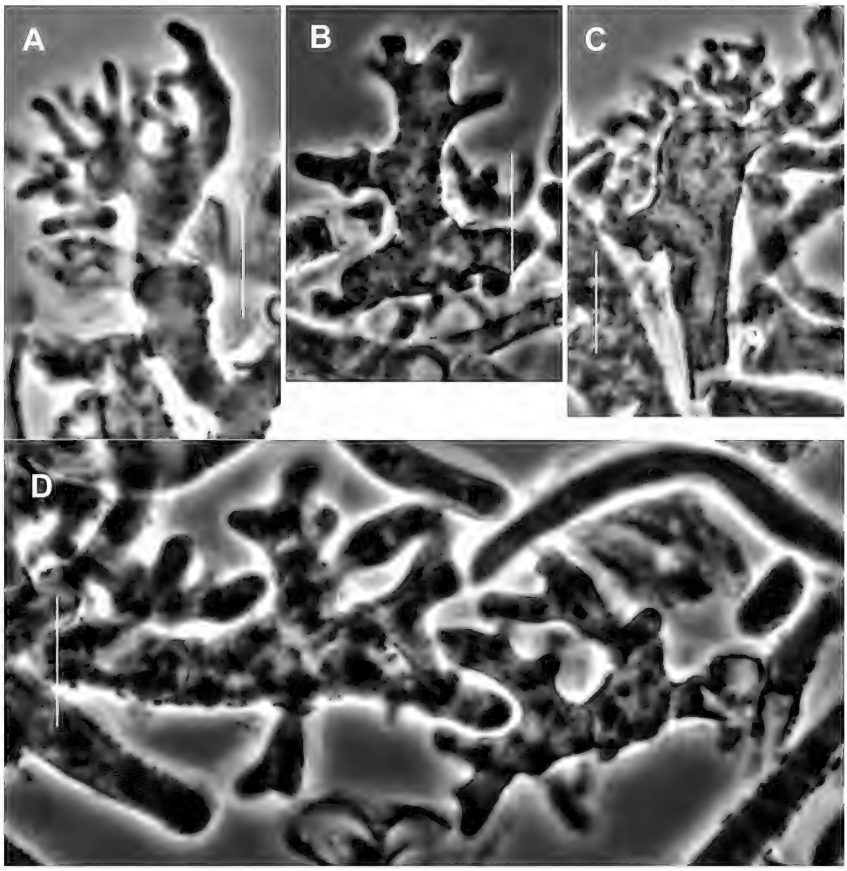

Fig. 45. *Pseudomarasmius patagonianus* (TENN-F-054432, holotype). Pileipellis diverticulate hyphal termini. Scale bars: 10 μm.

hyphae 2.55 μm diam, thick-walled (wall ≤1 μm thick), strictly parallel in slime matrix, hyaline, without clamp connections. Stipe cortical hyphae 35 μm diam, thick-walled, repent in thin slime matrix, roughened outward, without clamp connections, weakly dextrinoid (reddish tan Melzer's reagent + BF; reddish brown Melzer's reagent + PhC). Caulocystidia ≤65 × 3.55 μm, cylindrical, firm-walled, gnarled and often with rudimentary lobes, hyaline singly, dull brown in mass, without clamp connections.

Commentary: Collection TFB7363 (TENN-F-054432) comprises several basidiomata on hardwood substrate. TENN-F-054424, collected in the same

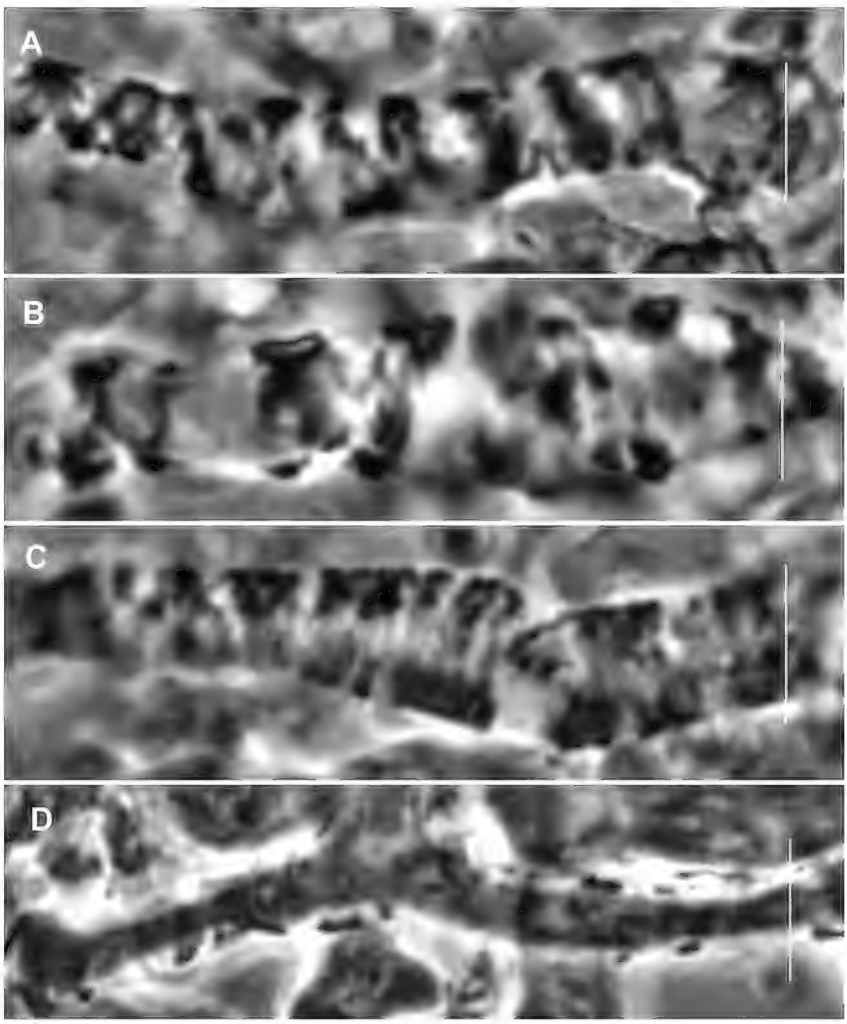

Fig. 46. *Pseudomarasmius patagonianus* (TENN-F-054432, holotype). Pileipellis hyphae. A, B. Encrusted hyphae. A, C. Ornamentation in stripes. B. Ornamentation of scabs -2 µm thick. D. Hypha with individual slime sheath and flake-like encrustation. Scale bars: 10 µm.

location at the same time, is a mixed collection composed of several mycenoid basidiomata and a single marasmielloid basidiome. The ITS-based sequence deposited in GenBank (KY352649; MF978330, rbp2) derived under this accession number must have come from the latter basidiome which is

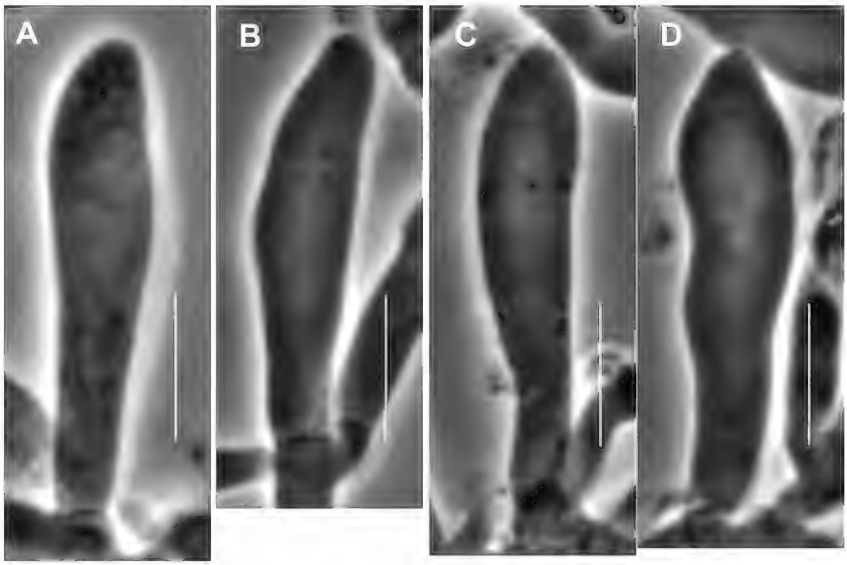

Fig. 47. *Pseudomarasmius patagonianus* (TENN-F-054432, holotype). Pleurocystidia. Scale bars: 10 µm.

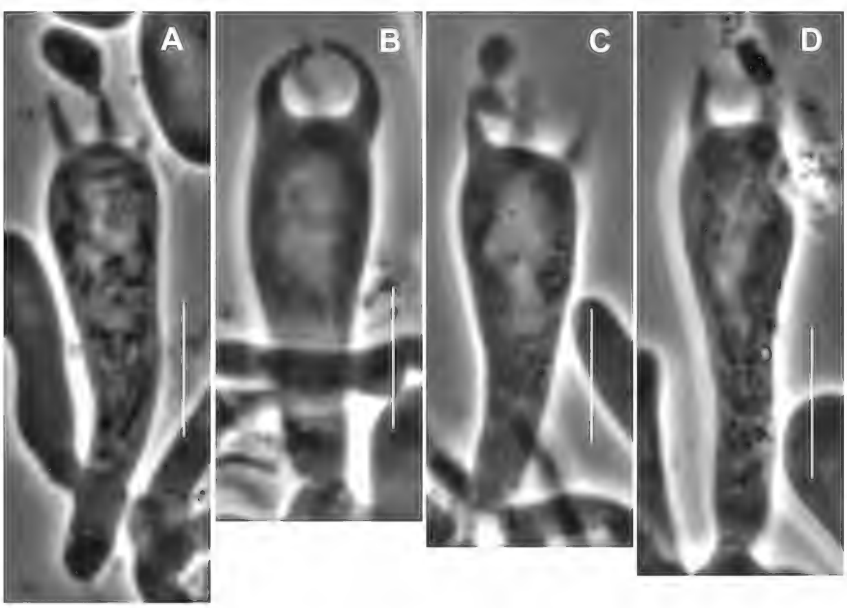

Fig. 48. *Pseudomarasmius patagonianus* (TENN-F-054432, holotype). Basidia. Scale bars: 10 µm.

morphologically identical to basidiomata in TFB7363: the sequence places the collection in *Pseudomarasmius* and the single basidiome matches the generic diagnosis. The basidiome has been segregated within the specimen.

As surveys of herbarium material and phylogenetic analysis of such collections are processed, there appears to be a convergent, relatively common basidiome architecture generally regarded as "marasmielloid," in which basidiomata conform to the following: 1) pileus small, rarely exceeding 15 mm broad, with thin, tough consistency; 2) lamellae usually distant, often reduced and with no anastomoses; 3) stipe central, usually strongly curved, rarely exceeding 10 × 2 mm, black or nearly so, usually glabrous, 4) fruiting on woody substrate often in vertical position; and 5) rhizomorphs usually present and sometimes dominant, slender, black. This architecture might be epitomized by *Gymnopus neobrevipes* (≡ *Marasmius brevipes*), almost indistinguishable from *Ps. nidus-avis* and *Ps. patagonianus* but distinguishable by presence of clamp connections, dominant rhizomorphs, more temperate distribution and unique ITS sequence.

Additional specimen examined: **CHILÉ**, **Chiloé**, **Isla Grande de Chiloé**, 20 km E Aucud, 41°53′10″S 73°38′52″W, 9.VI.1995, coll. RHP, TFB 7364 (TENN-F-054424).

Pseudomarasmius quercophiloides R.H. Petersen, **sp. nov.** Figs 49–59

IF 555732

Differs from *Gymnopus quercophilus* by its 1) lack of clamp connections; 2) abundant rhizomorphs that are resupinate on sclerophyllous leaves; 3) sulcate-striate pileus with low umbo; and 4) distribution in interior or subtropical China.

Type: China, Yunnan Prov., Anning Pref., grounds of Southwest Forestry University, 25°03′51″N 102°45′16″E, 10.VIII.1990, coll. RHP, Q. Wu, Li, TFB 3162 (**Holotype,** TENN-F-049177).

Etymology: Resemblance to *Marasmius quercophilus* Pouzar.

Basidiomata (Figs. 49a, 50) diminutive. Pileus (Fig. 49b) 25 mm broad, downturned, sulcate-striate with small umbo, matte, "vinaceous buff" (9B2). Lamellae (Fig. 49b) not collariate, 19–26 total lamellae, 8–11 through lamellae, shallow (<1 mm broad), thick with rounded edge, not marginate, "tilleul buff" (7B2) to "pinkish buff" (6A3). Stipe 8–14 × 0.6–0.9 mm, terete, dull brown apically and there minutely decorated with hyaline caulocystidia, downward appearing glabrous-shining but microscopically pruinose, black, insititious. Rhizomorphs plentiful, resupinate on sclerophyllous hardwood leaves (Fig. 51), dark copper color with minute fringe of ochraceous rust color, rarely becoming aerial but then never pileate.

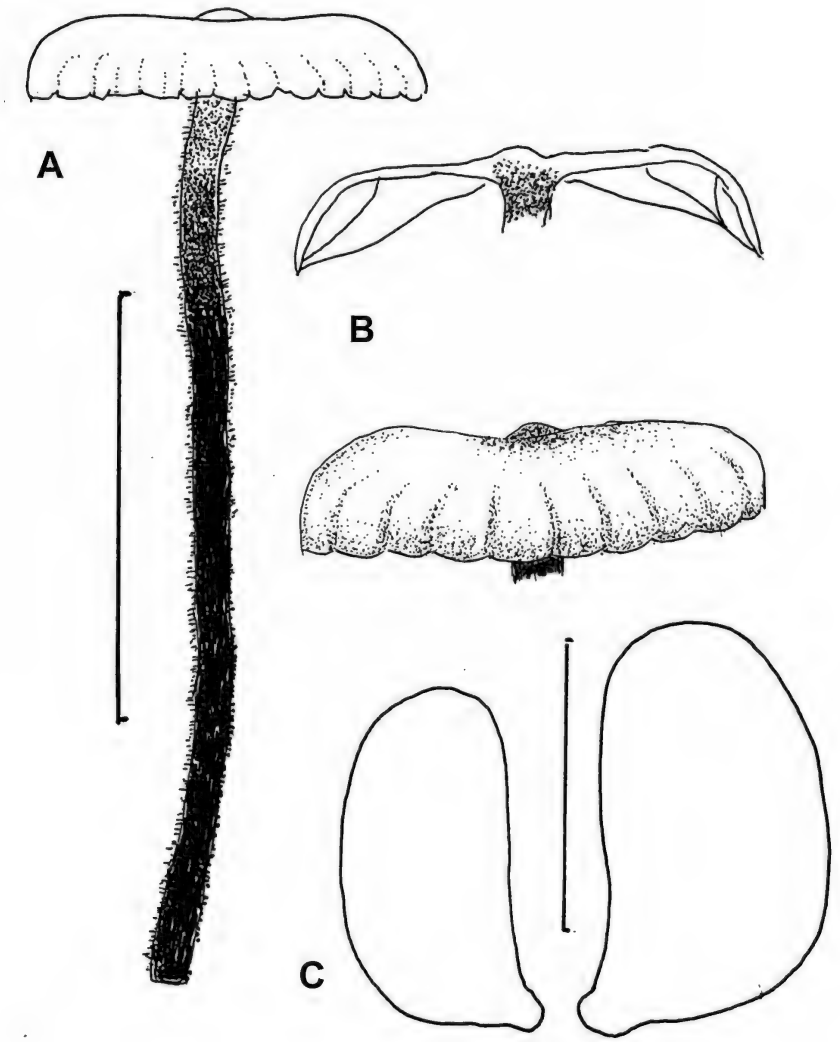

Fig. 49. *Pseudomarasmius quercophiloides* (TENN-F-049179, holotype). A. Basidioma. B. Pileus, exterior + cross-section. C. Basidiospores. Scale bars: A, B = 5 mm; C = 5 µm.

Distribution & phenology: On at least *Castanopsis* leaves in southwestern, subtropical China; summer.

Pileipellis composed of three hyphal types with no evidence of gelatinization: 1) repent hyphae (Fig. 52a) 3–6.5 µm diam, thin-walled,

FIG. 50. *Pseudomarasmius quercophiloides* (TENN-F-049179, holotype). Basidiomata on leaf surface. Scale bar = 10 mm.

FIG. 51. *Pseudomarasmius quercophiloides* (TENN-F-049179, holotype). Resupinate rhizomorphs on sclerophyllous leaves. Scale bar = 10 mm.

encrusted in scabs not in annular or striped configuration; profile scabs ≤1 µm thick; clamp connections not observed; 2) diverticulate hyphae (FIG. 52B,C) 3–6.5 µm diam, thin-walled, beset with numerous diverticula;

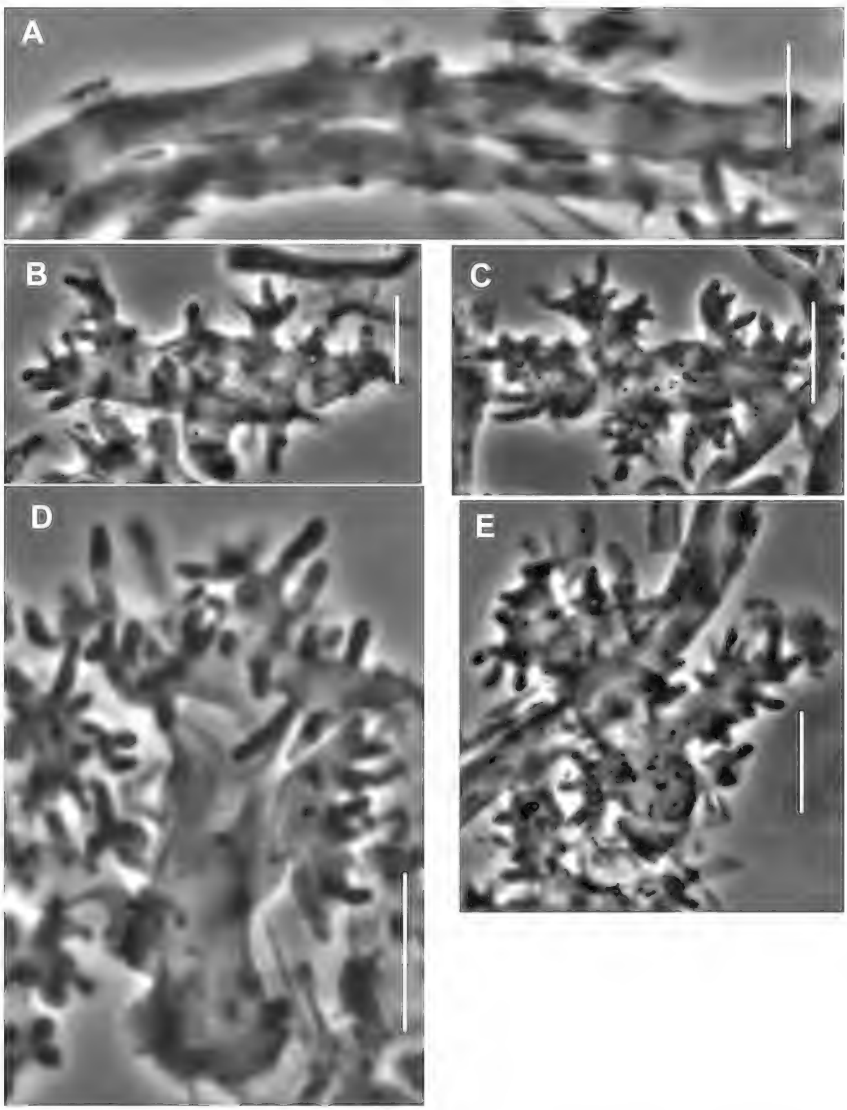

Fig. 52. *Pseudomarasmius quercophiloides* (TENN-F-049179, holotype). Pileipellis elements. A. Repent, encrusted hypha. B,C. Diverticulate hyphae. D,E. Broom cell-like hyphal termini. Scale bars: 10 μm.

diverticula digitate (not conical), 1–8 × 0.7–1.1 μm, often slightly gnarled, dense (PhC); and 3) diverticulate broom cell-like hyphal termini (Fig. 52D,E),

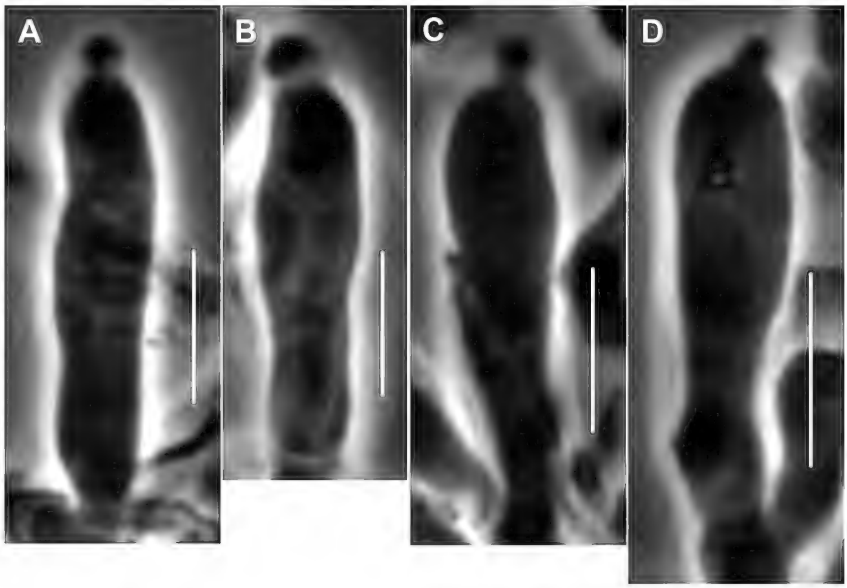

Fig. 53. *Pseudomarasmius quercophiloides* (TENN-F-049179, holotype). Pleurocystidia. Scale bars: 10 µm.

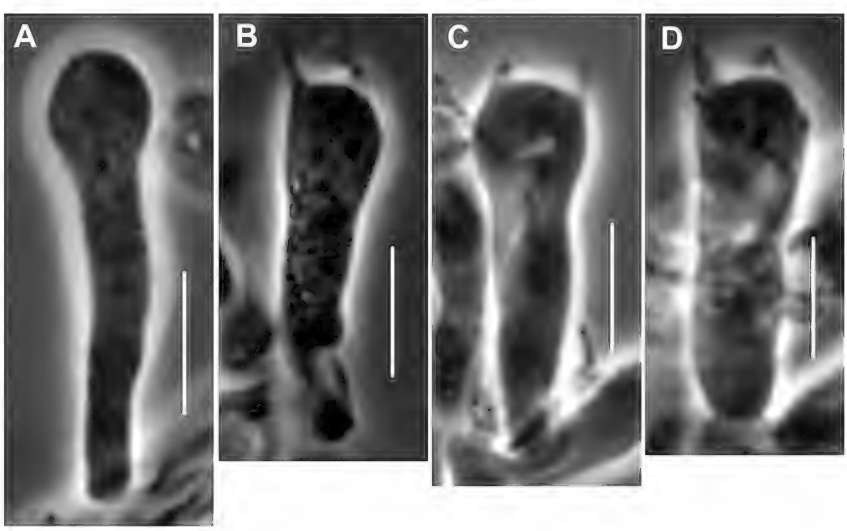

Fig. 54. *Pseudomarasmius quercophiloides* (TENN-F-049179, holotype). A. Basidiole. B–D. Basidia. Scale bars: 10 µm.

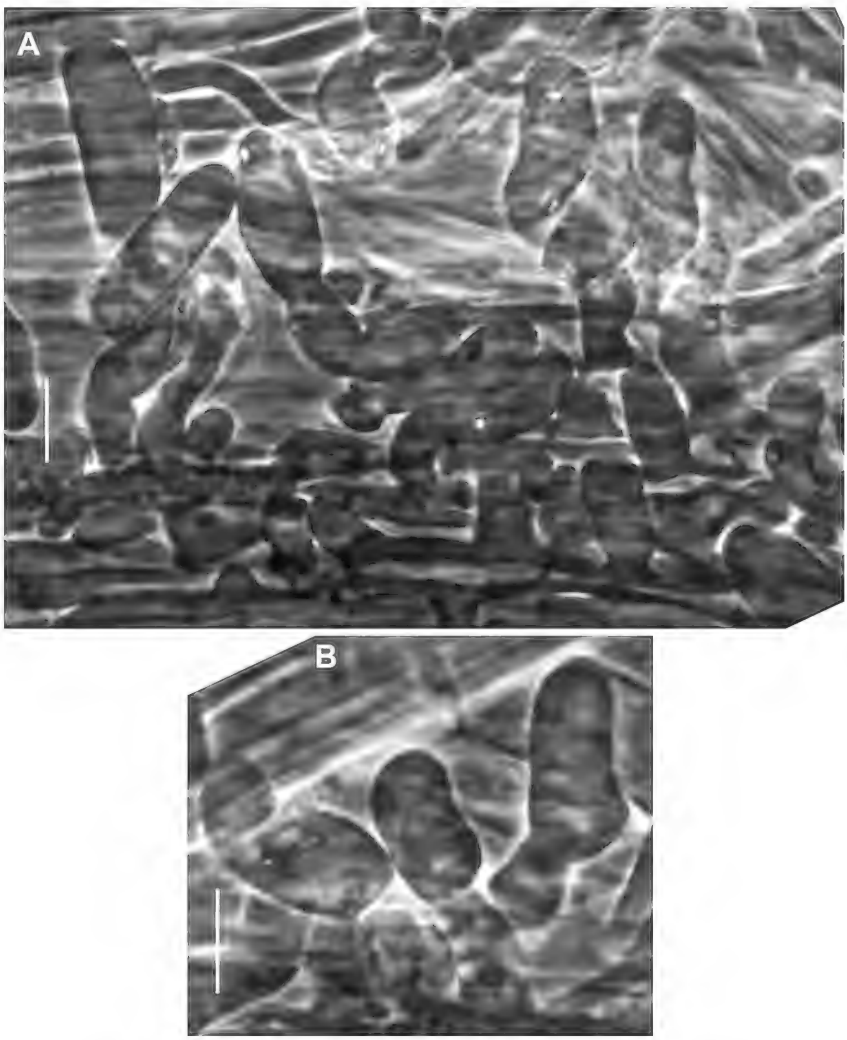

FIG. 55. *Pseudomarasmius quercophiloides* (TENN-F-049179, holotype). Clusters of upper stipe caulocystidia. Scale bars: 10 µm.

similar to diverticulate hyphae, without clamp connections. No evidence of gelatinization observed in pileipellis. Pileus trama loosely interwoven; hyphae 2–5.5 um diam, thin-walled, hyaline, without clamp connections. Hymenium composed of three elements with no evidence of gelatinization: 1) PLEUROCYSTIDIA (FIG. 53) occasional (not abundant), 19–24 × 5–6 um, fusiform to narrow-fusiform, often with small, subglobose, apical

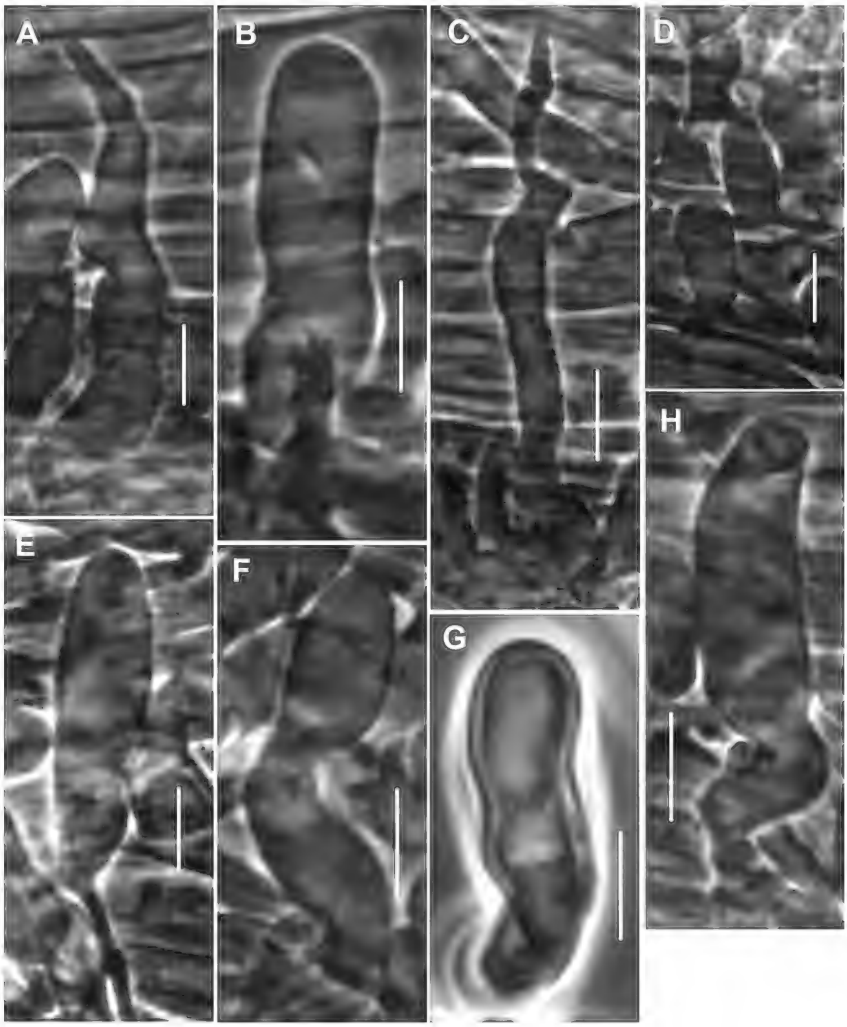

Fig. 56. *Pseudomarasmius quercophiloides* (TENN-F-049179, holotype).
Individual upper stipe caulocystidia. Note caulocystidial origins in D. Scale bars: 10 µm.

protuberance (appearing mammilate), without clamp connections; 2) basidioles (Fig. 54A) clavate to subcapitulate, without clamp connections; BASIDIA (Fig. 54B–D) (22–)27–30 × 6–7 µm, 4-sterigmate (sterigmata slender, easily collapsed), without clamp connections; and 3) CHEILOCYSTIDIA not observed. BASIDIOSPORES (Fig. 49C) 6–7 × 3–4(–5) µm (Q = 1.40–1.86;

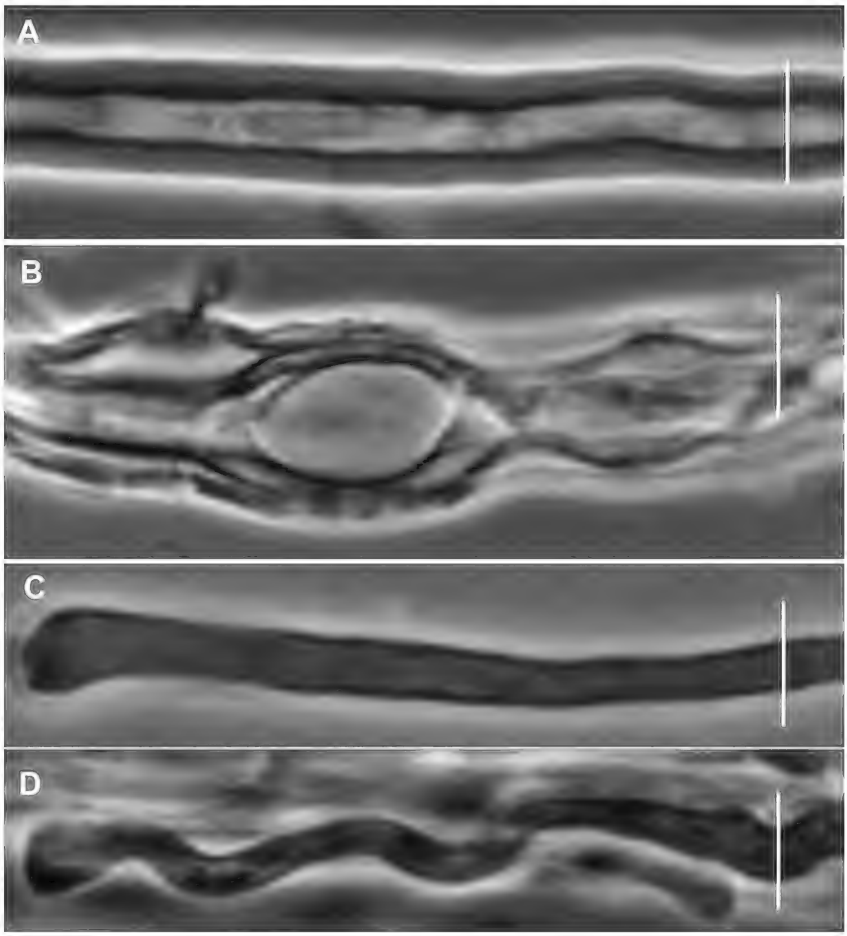

Fig. 57. *Pseudomarasmius quercophiloides* (TENN-F-049179, holotype). Lower stipe medullary hyphae. A. Stout, thick-walled hypha. B. Gelatinized or shredded stout hypha. C. Slender hypha. D. Serpentine slender hypha. Scale bars: 10 µm.

E^m = 1.53; L^m = 6.60 µm), ellipsoid, not tapering proximally, thin-walled, hyaline, inamyloid. Upper stipe medullary hyphae <12 µm diam, strictly parallel, free (no evidence of gelatinization), hyaline, with no clamp connections, thick-walled (wall ≤1.5 µm thick). Upper stipe cortical hyphae 4–6 µm diam, thick-walled (wall ≤1 um thick), strongly pigmented (olive brown, PhC), without clamp connections, decorated with numerous caulocystidia (Fig. 55); caulocystidia (Fig. 56) 3–30(–40) × 7–13 um,

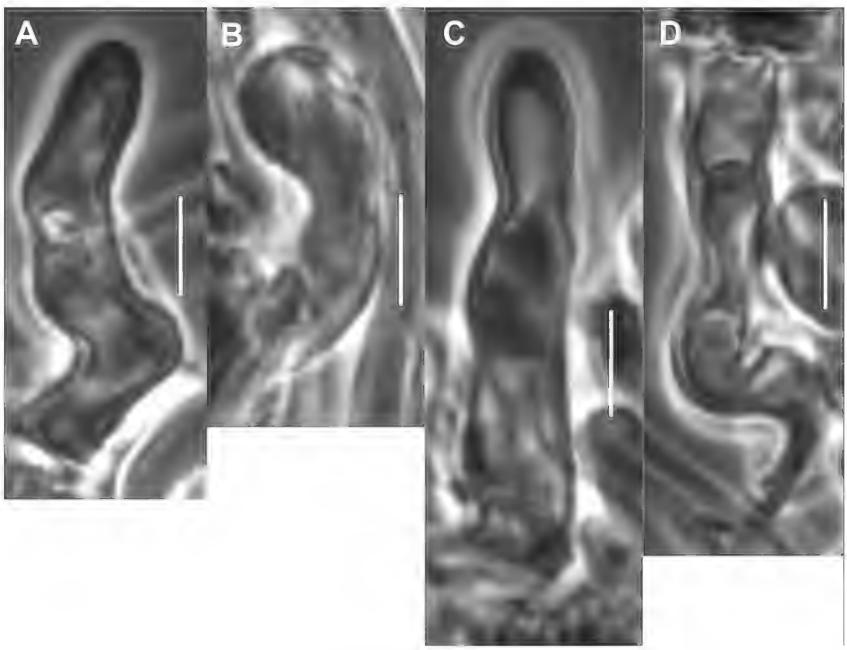

Fig. 58. *Pseudomarasmius quercophiloides* (TENN-F-049179, holotype). Individual lower stipe caulocystidia. Scale bars: 10 μm.

lobate to thumb-shaped, usually gnarled or constricted, firm- to thick-walled (wall ≤1 μm thick), weakly pigmented, arising as constricted side branches of surface cortical hyphae. Lower stipe medullary hyphae strictly parallel, of two types: 1) 5–8 μm diam, thick-walled (wall ≤2 μm thick), occasionally gelatinized (Fig. 57A) or shredded (Fig. 57B); and 2) slender, 2–2.5 um diam, thin-walled, straight (Fig. 57C) to serpentine (Fig. 57D), with dense contents (PhC). Lower stipe cortical hyphae 3.5–6 μm diam, thick-walled (wall ≤2 μm thick, often obscuring cell lumen), densely pigmented (dark olive brown, PhC), beset with crowded caulocystidia; CAULOCYSTIDIA (Fig. 58) 5–30 × 8–13 um, crowded, stout-vermiform, usually gnarled and/or constricted, thin- to thick-walled (wall ≤1 μm thick), hyaline to weakly pigmented proximally. Resupinate rhizomorph anatomy similar to that of lower stipe. Cortical hyphae with superficial film of gelatinous material (Fig 59A) acting as adhesive to the leaf surface. Rhizocystidia (Fig. 59B–E) widely scattered, similar to caulocystidia but thick-walled (wall ≤1.5 μm thick) and strongly pigmented.

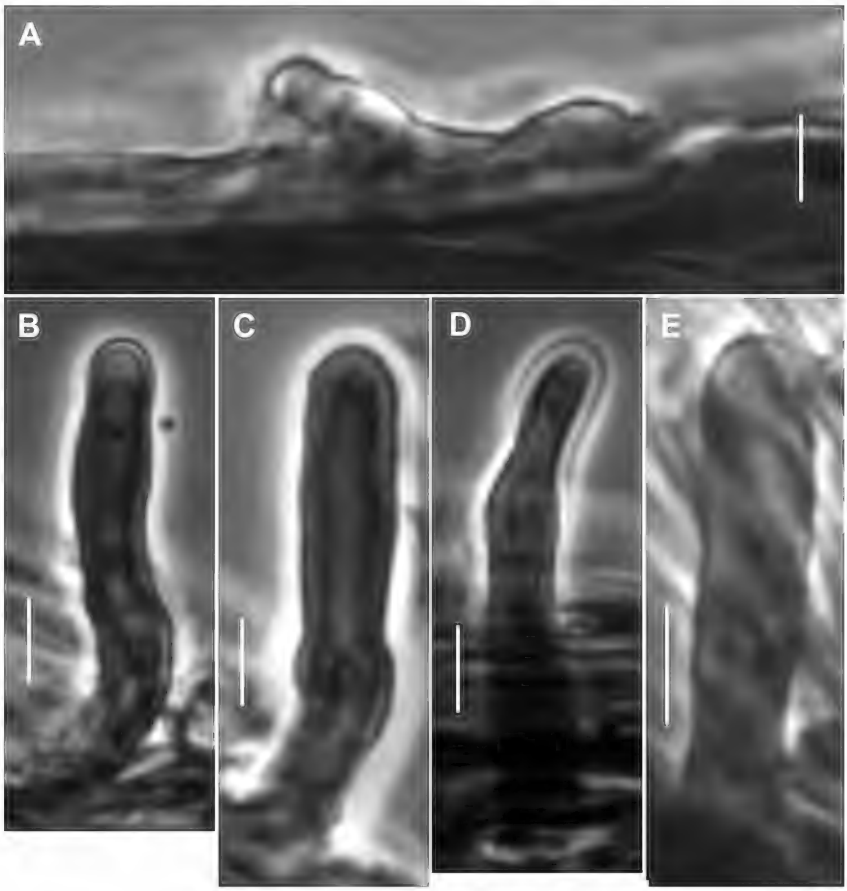

Fig. 59. *Pseudomarasmius quercophiloides* (TENN-F-049179, holotype). Rhizomorph anatomy. A. Surface of cortex with suggestion of superficial gel. B–E. Rhizocystidia. Scale bars: 10 μm.

Commentary: Similarities with *G. quercophilus*: 1) abundant rhizomorphs, not black (in *G. quercophilus* chestnut brown to red-brown), dominantly resupinate on sclerophyllous hardwood leaves; 2) pleurocystidial general shape and size; 3) pileus sulcate-striate with small umbo; and 4) basidiomata arising from leaf surface not from rhizomorphs. Dissimilarities to *G. quercophilus* include: 1) clamp connections lacking; 2) absence of cheilocystidia; 3) presence of pruinose caulocystidia.

The ITS sequence of *Ps. quercophiloides* is largely identical to GenBank sequence KF251072, deposited as *Gymnopus glabrocystidiatus* (not holotype) from South Korea (2 bp difference in 636bp). Geographical proximity and sequence homology suggest that these likely represent the same taxon.

Additional specimen examined: **China**, **Yunnan Prov.**, **Jinhong Pref.**, vic. Menghai, Xishuangbanna Nature Reserve, 8.VIII.990, coll. RHP, Q Wu, Li, TFB 3148 (TENN-F-049179)

Pseudomarasmius straminipes (Peck) R.H. Petersen, **comb. nov.** Figs 60–64

IF 555734

≡ *Marasmius straminipes* Peck, Bull. Buffalo Soc. Nat. Sci. 1: 59.

≡ *Chamaeceras straminipes* (Peck) Kuntze, Revis. Gen. P. 3(2): 457.

Holotype (implicit, Peck): United States, New York, Albany Co, Center (= Kamer), 42°39′10″N 73°45′52″W, Oct. 1872. C.H. Peck (NYS!).

Diagnostic characters include: 1) stipe capillary, buff above, ochraceous downward, glabrous-shining; 2) rhizomorphs usually common, pallid; 3) fruiting on fallen conifer needles, usually spruce/fir; 6) distribution in eastern North America.

Basidiomata (Fig. 60a) diminutive, marcescent, reviving. Pileus (1.5–) 3–7 mm broad, hemispherical or convex, expanding to plano-convex, occasionally with suggestion of low umbo, dull, opaque, glabrous or minutely suede-like, light brown (7D4-5) or pale greyish brown (7D3) overall when young, soon fading to pale brownish orange (7C3) or pale brownish grey (6B2, 6C3); disc smooth or weakly rugulose; margin rugulose-striate or rugulose but not striate, soon fading to greyish orange (6C2) or pale greyish orange (5B2), in age with a hint of grey and buff; context thin, buff, often fading to whitish, buff or pinkish buff overall. Lamellae adnate, subdistant, without anastomoses or interveining, narrow, whitish or buff when young, becoming greyish buff or pale brownish grey (6C3) in age; edges even or crystalline-fimbriate; lamellulae in 1–2 series. Stipe 10–35 × 0.2–0.5 mm, terete, equal, tough, rigid or wiry, glabrous-shining, sometimes tacky, hollow, instititious, brownish orange (5C4, especially downward) to yellow (4A5-6) or straw-colored overall when young or with a slightly paler apex, darkening overall with age to stramineous, becoming slightly more brownish at maturity, never dark brown or black. Rhizomorphs (Fig. 60A) extensive, with short resupinate lengths on needle surface, then loosely curly, <20 × 0.1–0.3 mm, repeatedly branched with branches often long and flagelliform, glabrous, dull yellow-brown in basal parts, champagne colored upward and finally off-white. Odor and taste negligible.

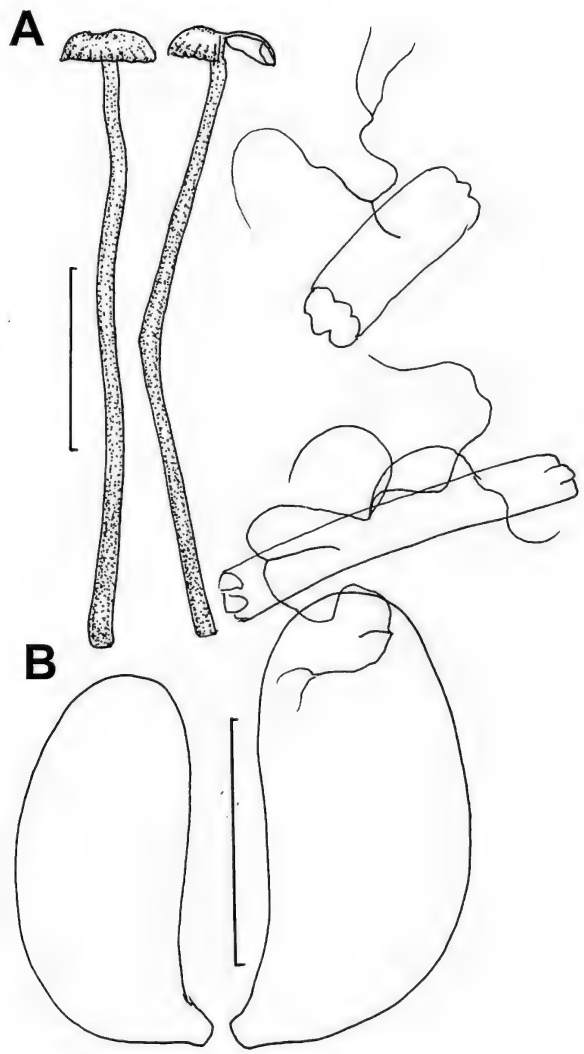

Fig. 60. *Pseudomarasmius straminipes* (TENN-F-026266).
A. Basidiomata and rhizomorphs. B. Basidiospores. Scale bars: A = 10 mm; B = 5 µm.

Habitat & phenology: Gregarious to scattered to dead conifer needles including *Picea/Abies* and *Pinus* (especially *P. strobus*); eastern North America [reported by Desjardin & Petersen (1989a) from Alabama, New Jersey, New York, North Carolina, Ohio and Tennessee]; summer–autumn.

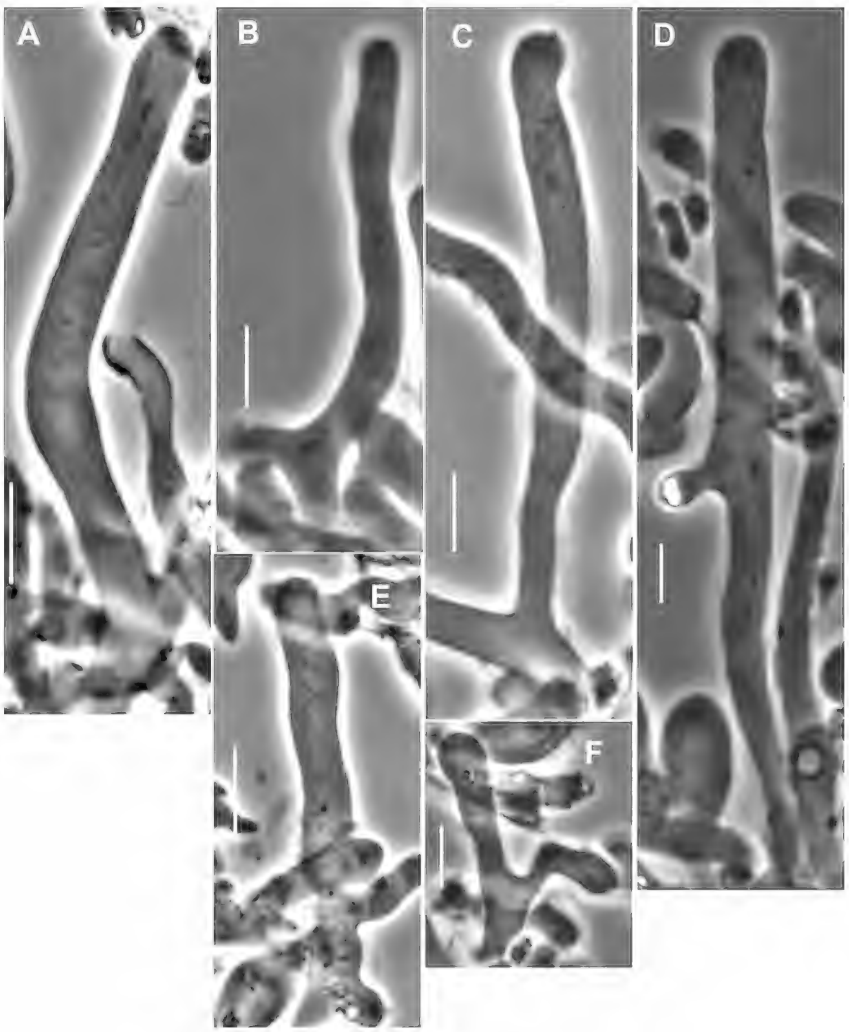

Fig. 61. *Pseudomarasmius straminipes* (TENN-F-047638).
Pileipellis hairs. Note production of abortive side branch. Scale bars: 10 µm.

Pileipellis without evidence of slime matrix, a well-developed *Rameales*-structure, of the following elements: 1) pileal hairs (Fig. 61) densely scattered, ≤80 × 4–6 µm, firm-walled, cylindrical, without clamp connections, often with aborted side branch, hyaline, usually subcapitulate; 2) repent hyphae 4–8.5(–15) µm diam, thin- to firm-walled, without clamp

FIG. 62. *Pseudomarasmius straminipes* (TENN-F-047642). Pileipellis elements. A–C. Diverticulate hyphae. D–K. Broom cell-like hyphal termini. Scale bars: 10 μm.

connections, strongly to weakly encrusted (crust material in scabs with vaguely annular to spiral patterning but occasionally protruding and then resembling diverticula); 2) scattered repent diverticulate hyphae (FIG. 62A–C) irregular in outline, often lobed, 2.5–8(–12) μm diam, hyaline to pale brownish, smooth or weakly encrusted, inamyloid; diverticula 1–8 × 1–3

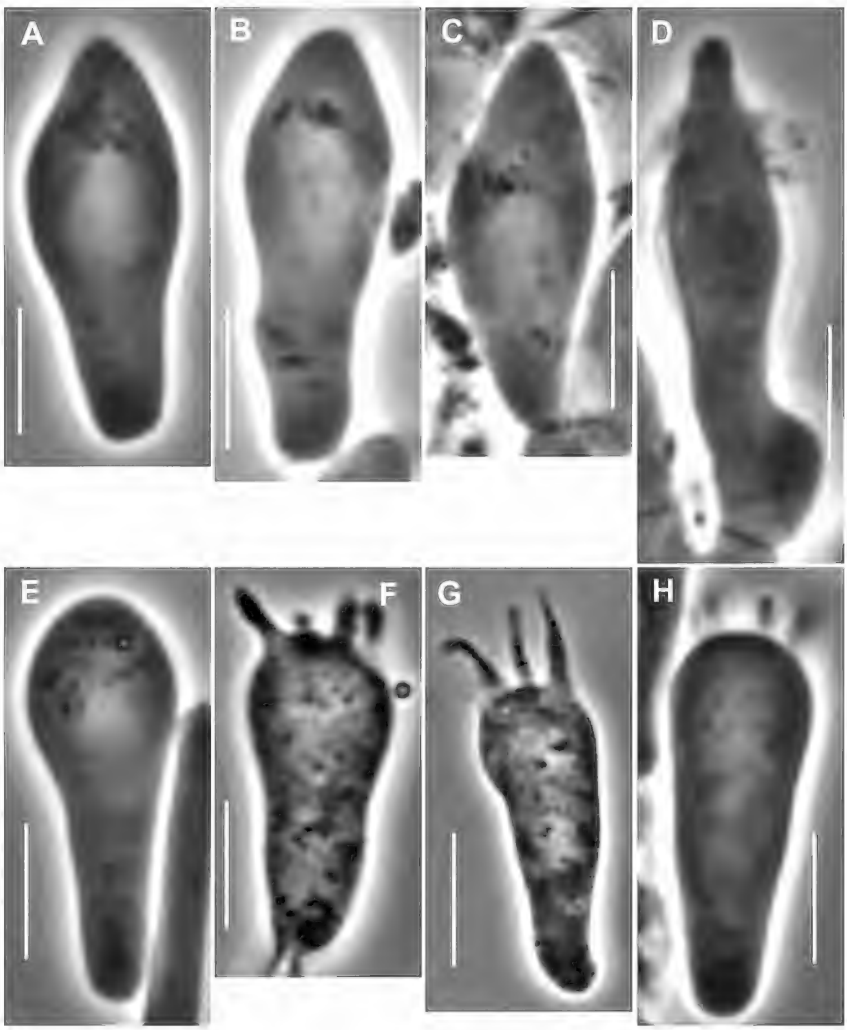

Fig. 63. *Pseudomarasmius straminipes* (TENN-F-047638). Hymenial structures. A–D. Pleurocystidia. E. Basidiole. F–H. Basidia. Scale bars: 10 µm.

µm, knob-like, often dichotomous and in fascicles, obtuse, thin-walled; and 3) broom cell-like hyphal termini (Fig. 62D–K) common, stalked (stalk 4–8 × 3.5–5.5 µm, without clamp connections), usually branched, distally variously lobed to diverticulate; diverticula 1–5 × 1–1.5 µm, nodulose, subrefringent, often appearing dichotomous. Pileus trama interwoven; hyphae 28–11)

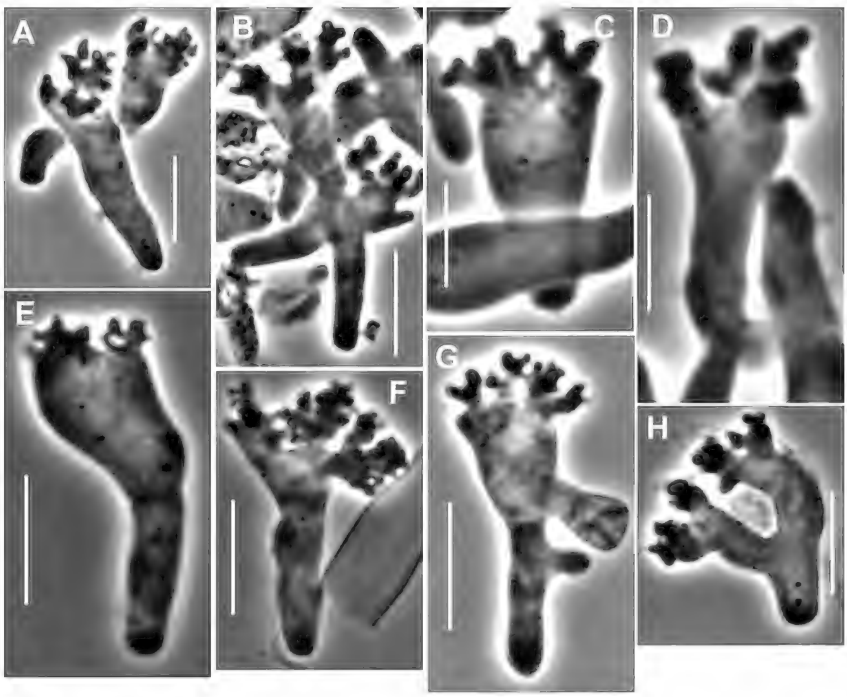

Fig. 64. *Pseudomarasmius straminipes* (TENN-F-047638).
Cheilocystidia. Note suggestion of dichotomous setulae. Scale bars: μm.

μm diam, inflated or not, hyaline, inamyloid, thin-walled, smooth or weakly incrusted; incrustations granular or often helical and yellowish to pale brownish. Lamellar tramal hyphae similar to pileus tramal hyphae, but hyaline and non-encrusted throughout, without clamp connections. Pleurocystidia (Fig. 63a–d) abundant, 21–26(–29) × 5–8 μm, fusiform to fusiform-rostrate, without clamp connections; contents more or less homogeneous. Basidioles (Fig. 63e) clavate; basidia (Fig. 63f–h) 19–28 × 6.4–10 μm, clavate, (2–)4-sterigmate, without clamp connections; contents more or less homogeneous; effete basidia emptying but not collapsing ("husking"). Basidiospores (Fig. 60B) 6.5–9.5 × 3.2–4.5 μm (Q = 1.70–2.40; E^m = 2.00; L^m = 8.00 μm), ellipsoid, slightly tapered proximally, smooth, hyaline, inamyloid; spore deposit whitish. Cheilocystidia (Fig. 64) scattered to abundant, 13–23(–33) × 10–15 μm 4.5–8(–11) μm, stalked (stalk ≤2–6 × 3.5–8 μm, thin-walled, without clamp connections), unbranched

or once-branched (and then branches short, stout), often lobed, setulose, hyaline, firm-walled; setulae 1–4 × 0.5–2 µm, sub-refringent, often saddle-shaped to dichotomous). Stipe medullary hyphae 3.5–7(–10) µm diam, strictly parallel, firm- to thick-walled (wall ≤0.5 µm thick, hyaline, Melzer's reagent) without evidence of slime matrix (Melzer's reagent, PhC), without clamp connections. inamyloid. Stipe cortical hyphae 1.5–6.5 µm diam, strictly parallel, thick-walled (walls ≤2.5 µm thick, non-encrusted), smooth, yellowish or pale brownish orange, moderately dextrinoid (Melzer's reagent + BF). Rhizomorph tissue similar to that of the stipe, with dextrinoid cortical hyphae. Clamp connections absent on all tissues.

Commentary: Protologue (Peck 1873 Bull. Buffalo Soc. Nat. Sci. 1(2): 59.): "Pileus membranaceous, hemispherical or convex, smooth, striate, whitish; lamellae distant, unequal, white; stem corneous, smooth, shining, filiform, inserted, pale straw colored. Plant 1″–2″ [inches] high, pileus 1″–3″ [lines] broad. Fallen leaves of pitch pine, *Pinus rigida*. Center [N.Y.] October."

After examination of the type specimen of *M. straminipes*, Gilliam (1976: 136) opined that: "The type specimen is closest to *Marasmiellus*," and reviewed some putative diagnostic characters. In the same publication, Gilliam (1976: 131) reported on another Peck taxon, *M. filopes* Peck, basidiomata of which are similar to those of *M. straminipes,* and stated: "There is too little left of the specimen to section," but concluded that "*M. filopes* is nearest *Marasmiellus*." Transfers of neither species (*M. straminipes*, *M. filopes*) to *Marasmiellus*, however, were formally accomplished. Redhead (1980), in his treatment of *Marasmiellus filopes*, did not mention or compare *M. straminipes* (validly published by Peck 1873, repeated in 1874), but, like Gilliam (1976), considered *M. filopes*, *M. thujinus* Peck, and *M. piceina* Kauffman as taxonomic synonyms. In a later discussion of clampless *Marasmius* taxa, Redhead (1984) rejected Gilliam's (1976) opinion of *M. straminipes* as *Marasmiellus*, retaining the species in *Marasmius* sect. *Androsacei*, but without mention of *Marasmiellus filopes* and its synonyms. Redhead (1984) mentioned the clampless state of *M. straminipes* by way of comparison with *M. pallidocephalus*. Desjardin (1989) examined Peck's type specimens of *M. straminipes* and *M. filopes*. Still later, in a paper redescribing *Marasmius straminipes* (Desjardin & Petersen 1989b), *M. straminipes* was again reported as clampless and Redhead's (1984) retention of *M. straminipes* in *Marasmius* sect. *Androsacei* was accepted, but *M. filopes* was not mentioned. In addition to the characters dictating placement of *M. straminipes* in *Marasmius* for Redhead (1984), Desjardin & Petersen

(1989b) added the dextrinoid reaction on stipe medullary hyphae in *M. straminipes*, theretofore unknown in *Marasmiellus*.

Description of basidiomata exhibiting clamp connections and those lacking clamps as forms or varieties of the same species is commonly found in the literature. Often, the clampless state is found accompanied by 2-sterigmate basidia and somewhat larger basidiospores than expected (see such forms in *Hymenopellis,* Petersen & Hughes 2010; and in *Mycena*, Kühner 1938, Lamoure 1957a,b, 1959, 1960). Upon further study, such forms may be found to be technically anamorphic (asexual) structures reproducing without meiosis and existing in a haploid state. In clampless forms in *Gymnopus* subg. *Gymnopus*, however, basidia appear to be 4-sterigmate and basidiospore metrics conform to the norms expected. Causes for such correlation remain opaque. In background research resulting in this paper, *Ps. efibulatus* was first noted as a clampless form of an undescribed *Marasmius* species. *Marasmius straminipes* (clampless) was thought to have a variety with clamp connections (*M. straminipes* var. *fibulatus* Desjardin & R.H. Petersen 1989. Bull. Torrey Bot. Club 49: 184.) With the proposal of *Pseudomarasmius*, a different avenue is offered, with molecular analyses important. DNA sequences of the analogous forms might clarify taxonomy, but so far such sequences have not been produced.

The proposed transfer of *M. straminipes* to *Pseudomarasmius* is based on morphological characters: unfortunately, sequences derived from *M. straminipes* basidiomata have consistently been "dirty," with more than one simultaneous sequence overlapping one another. The close resemblance to *Ps. glabrocystidiatus* in form, ecology, and microstructure, however, makes our transfer relatively comfortable.

Specimens examined: **UNITED STATES**, **North Carolina**, **Macon Co.**, vic. Otto, Coweeta Hydrologic Laboratory, Ball Creek area, 35°02′58″N 83°26′20″W, 13.VIII.1987, coll. D.E. Desjardin, DED 4458 (TENN 47642); vic. Highlands, Blue Valley, ca 3 mi up Clear Creek Rd., 9.VII.1991, coll. D.E. Desjardin, DED 5149 (TENN-F-050018, SFSU); **Swain Co.**, vic. Bryson City, GSMNP, Clingman's Dome, 1.VIII.1989, coll. S.A. Gordon, TFB 2125 (TENN-F-049143). **Tennessee**, **Sevier Co.**, GSMNP, Old Indian Gap Road off Clingman's Dome Road, 11.VI.1986, coll. D.E. Desjardin, DED 3578 (TENN-F-047638); Indian Gap, 35°36′34″N,83°26′47″W, 12.VI.1952, coll. L.R. Hesler (as *Marasmius* sp.), det. D.E. Desjardin (TENN-F-026266).

General discussion

The clampless state has always raised questions about nuclear behavior in the basidial primordium and basidiospores (see Petersen 1995). Often, the clampless state is accompanied by 2-sterigmate basidia, with the ploidy of

parent mycelium, dikaryotization, meiosis and subsequent mitosis unclear (Petersen 1978). In *Pseudomarasmius,* however, the clampless state seems coupled with 4-sterigmate basidia (rarely 2-sterigmate in *Ps. pallidocephalus* and *Ps. nidus-avis*). This allows some conjecture that parent mycelium was dikaryotic, with diploidization in the basidial primordium probable, although nuclear segregation in the basidium and nuclear number in the basidiospores remains unknown. Clarifying experiments in this situation cannot be assumed by culturing single basidiospores and pairing resultant cultures, for the nuclear condition of the "monokaryons" is unknown until observed Cytogenetic evidence must be gathered directly, usually with the aid of DAPI staining and phase contrast microscopy or some more cumbersome stains (Restivo & Petersen 1976, Hubbard & Petersen 1979).

In an entirely different direction, if any doubt remains, morphological identification and especially generic (or infrageneric) placement has become almost impossible in large groups of marasmioid fungi. *Gymnopus* in the sense of Wilson & Desjardin (2005), especially, has been repeatedly shown to form a monophyletic clade but inclusive of disparate basidiomatal morphology, ranging from *G. androsaceus* (traditionally type of *Marasmius* sect. *Androsacei*) and *G. perforans* (traditionally type of *Micromphale* sect. *Perforantia*) rather typical of marasmioid stature, to *G. fusipes* (typus generis) forming much larger, coarser and fasciculate basidiomata, and *Caripia* which forms only a subclavarioid hymenophore. Typical *Micromphale* (*M. venosum* typus generis), with gelatinized tissue layer in the pileus trama, also is now found in the *Gymnopus* clade (see Fig. 1).

In another different taxonomic direction, *Mycetinis* (and *Paramycetinis*, see above), *Rhodocollybia, Lentinula, Connopus*, and *Pseudomarasmius* (see above), all traditionally within larger genera, are now known to resolve as monophyletic clades (see Fig. 1).

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Caliciopsis sambaibae sp. nov. from the Brazilian Cerrado

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Abstract—A new species, *Caliciopsis sambaibae*, is described associated with *Davilla elliptica* plants. The collections were made in the Cerrado of Sete Cidades National Park, in the municipality of Piracuruca, Piauí State, Brazil.

Key words—*Ascomycota*, *Coryneliaceae*, *Coryneliales*, *Eurotiomycetes*, sambaíba

Introduction

The Cerrado, designated as a neotropical plant diversity hotspot (Simon & al. 2009), is the main vegetation type of five Brazilian states—Minas Gerais, Goiás, Mato Grosso do Sul, Maranhão, and Tocantins—and also occurs in six other states—Bahia, Mato Grosso, Piauí, São Paulo, Paraná, and Rondônia (Beuchle & al. 2015). This vegetation covers about 23% of Brazil and incorporates c. 12,000 species of angiosperms (Zappi & al. 2015). *Davilla* Vand., one of the most diverse genera within *Dilleniaceae* Salisb., comprises about 30 neotropical species of lianas and erect or climbing shrubs (Fraga & Stehmann 2010). Plants of this genus are locally known as "sambaíba" and are commonly used in traditional medicine in anti-inflammatory treatments (Lima & al. 2014).

The survey of fungi associated with plants from the Cerrado has revealed many new fungi (Dornelo-Silva & Dianese 2004, Dornelo-Silva & al. 2007)—c. 100 new species and 20 new genera of fungi (mainly ascomycetes) have been described (Dianese 2000, Hernández-Gutiérrez & Dianese 2008, Pereira-Carvalho & al. 2009, Armando & al. 2015, Firmino & al. 2016, Melo & al. 2017).

Caliciopsis (*Coryneliaceae*), represented by c. 30 species and found in temperate and tropical regions of North and South America, Eurasia, and Australia (Crous & al. 2016, Pratibha & al. 2010, Fitzpatrick 1920), is characterized by long black perithecia lacking paraphyses, evanescent asci, and brown ascospores. Some species produce an asexual morph, which is rarely observed because the conidia are produced within stromatic pycnidia (Garrido-Benavent & Pérez-Ortega 2015). Some species are associated with tree cankers or leaf spots (Jordal & al. 2004, Pratibha & al. 2010); severe cankering is caused by the type species *C. pinea* Peck (on *Pinus*), *C. calicioides* (Fr.) Fitzp. (on *Populus*), and *C. pleomorpha* P.A. McGee & Pascoe (on *Eucalyptus*) (Benny & al. 1985, Fitzpatrick 1920, 1942; Munck & al. 2015, Pascoe & al. 2018).

The symptoms on our collections of *Davilla elliptica* leaves began with yellow spots, which turned necrotic and brown. In the lesions, we noted numerous fungal structures similar to black spines corresponding to the rostrate perithecial necks characteristic of a *Caliciopsis* fungus. As the morphology and biometric data of our specimens do not correspond with any described *Caliciopsis*, we propose a new species, *Caliciopsis sambaibae*.

Materials & methods

During 2014–16, *Davilla elliptica* leaves bearing signs of fungal infection were collected in Sete Cidades National Park in the municipality of Piracuruca, Piauí State, Brazil. The leaves were examined under a stereoscopic microscope and fragments and hand sections of the ascomata were mounted between slide and coverslip using Amann's lactophenol. Leaf samples were submitted to scanning electron microscopy (SEM) in the Electron Microscopy laboratory of the Escola Superior de Agricultura Luiz de Queiroz, Universidade de São Paulo, as follows: leaf fragments containing the fungal structures were placed on filter paper moistened in a Petri dish, along with a small plastic container containing ca. 1 mL of 2% OsO_4 in aqueous solution. The container was wrapped with Parafilm and foil and left overnight (Kitajima & Leite 1999). The plate was then opened, and the leaf fragment was removed, air dried, mounted in the scanning electron microscope stub port with carbon double-sided adhesive tape, and covered with a thin layer of gold on a Bal-tec SCD050 sputter coater. The sample was examined and digitally recorded with a LEO 435 VP scanning electron microscope at 20 kV and a 10-mm working distance.

Specimens were conserved in the herbarium, Universidade Federal de Viçosa, Minas Gerais, Brazil (VIC).

Taxonomy

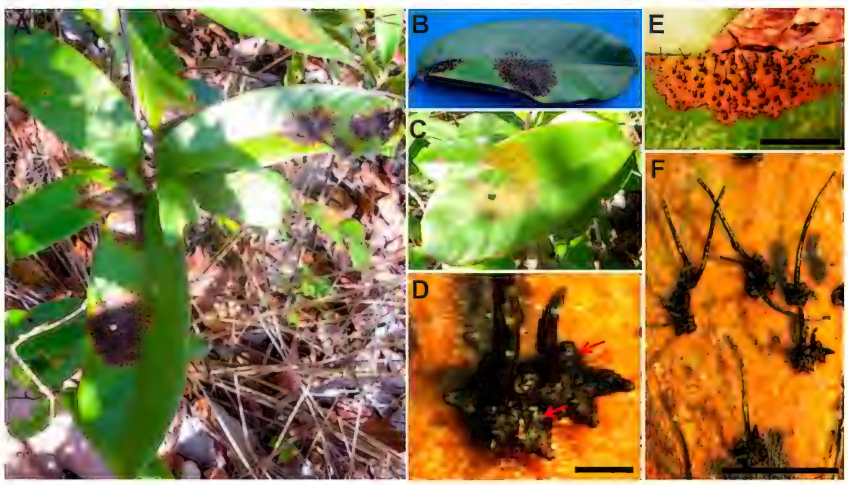

Plate 1. *Caliciopsis sambaibae* (holotype, VIC 44133) on *Davilla elliptica*. A–C. leaf symptoms; D–F: perithecia on leaves (LM). Scale bars: D = 30 µm, E, F = 100 µm.

Caliciopsis sambaibae J.L. Bezerra, M.P. Melo & Beserra, **sp. nov.** Figs 1, 2

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Differs from other *Caliciopsis* spp. by its perithecia having scars on their middle third and a basal dilation where ascospores are stored, and by its dilleniaceous host.

Type: Brazil, Piauí, Piracuruca 4°02′08″S 41°40′45″W, on living leaves of *Davilla elliptica* A.St.-Hil. (*Dilleniaceae*), 20 May 2016, M.P. Melo (**Holotype**, VIC 44133).

Etymology: Referring to "sambaíba", the common name of the host.

Spots yellowish, becoming brown and necrotic with age. Colonies amphigenous, rarely epiphyllous. Stromata irregular to circular in outline, superficial mycelium absent; internal mycelium intercellular; stromata black, formed on the leaf surface from which the perithecia and pycnidia are inserted. Sexual morph: perithecia ellipsoid, with long necks, simple or forked, straight or curved, 550–730 × 30–60 µm, with a swollen ascogenous region near the base; ring-like scars and apical filaments on the necks of mature perithecia; asci bitunicate with eight ascospores, formed in the ascogenous swellings, evanescent, 17–20 × 5–7 µm (n = 20); ascospores 1-celled, smooth-walled,

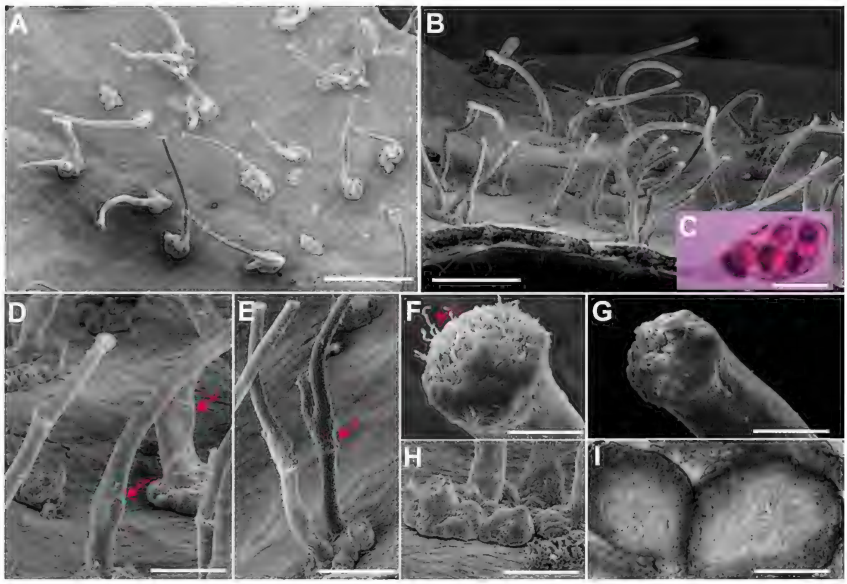

Plate 2. *Caliciopsis sambaibae* (holotype, VIC 44133) on *Davilla elliptica*. A, B. perithecia (SEM); C. asci and ascospores (LM). D, E. scars (red arrows) on face of perithecia (SEM); F. apical filaments (red arrow) on the neck of mature perithecium (SEM); G. neck of immature perithecium (SEM); H. pycnidia in the basal stroma (SEM); I. cross sections of pycnidia (SEM). Scale bars: A, B = 1 mm; C = 10 µm; D, E = 200 µm; F, G = 20 µm; H = 200 µm; I = 10 µm.

globose to lenticular, brown, 3–6 × 3–5 µm. pycnidia cespitose, developed at the perithecial base, irregular, stromatic, 23–20 µm diam.; conidiogenous cells holoblastic, nearly inconspicuous; conidia 1–celled, smooth, hyaline, ellipsoid, 3–4 × 2 µm.

Additional specimen examined: **BRAZIL**, **Piauí**, **Piracuruca**, on living leaves of *Davilla elliptica*, 11 October 2014, J.E.A. Beserra Jr. (VIC 44132).

Discussion

Caliciopsis sambaibae produces ellipsoid, spine-shaped perithecia with ascogenous swellings near the bases where the asci are formed. Sections in this region revealed asci in formation, and ascogenous swellings were not observed in immature perithecia. The apex of the perithecial ostiole is somewhat dilated, and hyphal filaments may assist in the transfer of ascospores to this region. Due to their evanescent nature, only a few intact asci could be observed. Possibly for this reason, asci have been observed only in *C. indica* J. Pratibha & Bhat, *C. valentina* Garrido-Ben. & Pérez-Ort.,

C. calicioides, and *C. beckhausii* (Körb.) Garrido-Ben. & Pérez-Ort. (Garrido-Benavent & Pérez-Ortega 2015, Jordal & al. 2014, Pratibha & al. 2010). After disintegration of the asci, passive ascospore liberation and agglomeration occur at the extremities of the perithecial necks. The presence of pycnidia immersed in plant tissue separates *C. arrhiza* (Pat. & Gaillard) Bat. & J.L. Bezerra and *C. confusa* Bat. (Batista & Maia 1964, Batista 1956) from *C. sambaibae*. The presence of scars in the middle or near the apex of the ostiole, as well as bifurcated ostioles distinguish *C. sambaibae* from other *Caliciopsis* species. The pycnidia of *C. sambaibae* are generally produced in groups inserted in the basal stroma, a morphological feature shared with *C. beckhausii*. Although most *Caliciopsis* species are associated with tree cankers (Jordal & al. 2004, Benny & al. 1985, Fitzpatrick 1942), we did not observe cankers in *Davilla elliptica* plants. *Caliciopsis indica* is the only species associated with leaves (Pratibha & al. 2010).

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Morphological and molecular identification of *Phlebia wuliangshanensis* sp. nov. in China

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Abstract —A new white-rot fungus, *Phlebia wuliangshanensis,* is proposed based on a combination of morphological features and molecular evidence. The species is characterized by an annual growth habit, resupinate basidiocarps with a smooth to tuberculate hymenial surface, a monomitic hyphal system with thin- to thick-walled generative hyphae bearing simple septa, presence of cystidia, and narrow ellipsoid to ellipsoid basidiospores (5–6 × 3–3.7 µm). Our phylogenetic analyses of ITS and LSU nrRNA sequences performed with maximum likelihood, maximum parsimony, and Bayesian inference methods support *P. wuliangshanensis* within a phlebioid clade in *Meruliaceae* (*Polyporales*). ITS+nLSU sequence analyses of additional *Phlebia* taxa strongly support *P. wuliangshanensis* within a monophyletic lineage grouped with *P. chrysocreas* and *P. uda.*

Key words—*Basidiomycota, Ceriporiopsis,* taxonomy, wood-inhabiting fungi, Yunnan Province

Introduction

Phlebia Fr. (*Meruliaceae*, *Polyporales*) is typified by *P. radiata* Fr. (Fries 1821). Basidiocarps are resupinate or rarely pileate with a subceraceous to subgelatinous consistency when fresh and membranaceous to coriaceous when dry. The hymenophore may be smooth, tuberculate, phlebioid,

odontoid, merulioid, or poroid. Microscopic characters include a monomitic (rarely dimitic) hyphal structure with clamp connections or simple-septa, narrowly clavate basidia, and hyaline basidiospores that are thin-walled, smooth, allantoid to ellipsoid, acyanophilous, and negative in Melzer's reagent (Bernicchia & Gorjón 2010). So far about 100 species have been accepted in the genus worldwide (Fries 1821; Ginns 1969; Nakasone & Burdsall 1984, 1995; Dhingra 1989; Nakasone 1997, 2002, 2003, 2009; Roberts 2000; Gilbertson & Hemmes 2004; Duhem & Michel 2007; Duhem 2009, 2013; Bernicchia & Gorjón 2010; Singh & al. 2010; Westphalen & al. 2018; Gorjón & Greslebin 2012; Kaur & al. 2017; Shen & al. 2018).

Recent, molecular studies have elucidated the classification of *Phlebia* among corticioid homobasidiomycetes (Larsson & al. 2004; Larsson 2007; Tomšovský & al. 2010; Binder & al. 2013, Justo & al. 2017; Shen & al. 2018). Larsson & al. (2004) showed that *Phlebia* clustered into a phlebioid clade and grouped with *Ceriporia* Donk and *Gloeoporus* Mont. Larsson (2007) emended part of *Polyporales* and demonstrated that *Phlebia* was polyphyletic and nested within *Meruliaceae*. A phylogenetic study of European taxa of *Ceriporiopsis* Domański showed that *Phlebia radiata* and the generic type of *Ceriporiopsis*, *C. gilvescens* (Bres.) Domański, grouped closely on the basis of combined nuclear ribosomal large subunit RNA (nLSU) and mitochondrial ribosomal small subunit rRNA (mtSSU) gene sequences (Tomšovský & al. 2010). Binder & al. (2013) multi-gene sequence analyses placed *P. radiata* within a phlebioid clade and apparently grouped with *Ceriporiopsis* and *Climacodon* P. Karst. Also using multi-gene datasets, Justo & al. (2017) revised the family-level classification of *Polyporales*, including eighteen families. They showed that *P. radiata* belonged to *Meruliaceae* and grouped with *Aurantiporus* Murrill and *Ceriporiopsis gilvescens*. Shen & al. (2018) described a new *Phlebia* species based on morphological characters and rDNA sequences. This species belonged within the phlebioid clade and was related to *P. radiata*.

During our investigations of wood-inhabiting fungi in southern China, we found an additional taxon that could not be assigned to any described species. In examining the taxonomy and phylogeny of this new species, we employed a two-gene molecular phylogenetic approach using internal transcribed spacer (ITS) and long subunit (nLSU) plus an expanded sampling of *Phlebia* isolates.

Materials & methods

The specimens studied are deposited at the herbarium of Southwest Forestry University (SWFC). Macro-morphological descriptions are based on field notes. Colour terms follow Petersen (1996). Micro-morphological data were obtained

Table 1. Species, specimens, and sequence data used in this study. New sequences in **bold**.

Species name	Sample no.	GenBank accession no.		References
		ITS	LSU	
Abortiporus biennis	TFRI 274	EU232187	EU232277	Unpublished
Antrodia albida	CBS 308.82	DQ491414	AY515348	Kim & al. 2007
A. heteromorpha	CBS 200.91	DQ491415	AY515350	Kim & al. 2007
Antrodiella americana	Gothenburg 3161	JN710509	JN710509	Binder & al. 2013
A. semisupina	FCUG 960	EU232182	EU232266	Binder & al. 2005
Ceriporiopsis gilvescens	BRNM 710166	FJ496684	FJ496720	Tomšovský & al. 2010
Climacocystis borealis	KH 13318	JQ031126	JQ031126	Binder & al. 2013
Coriolopsis caperata	LE(BIN)-0677	AB158316	AB158316	Tomšovský & al. 2010
Dacryobolus karstenii	KHL 11162	EU118624	EU118624	Binder & al. 2005
Daedalea quercina	HHB 8735	FJ403214	FJ403214	Lindner & al. 2011
Earliella scabrosa	PR 1209	JN165009	JN164793	Binder & al. 2005
Fomitopsis pinicola	CCBAS 536	FJ608588	—	Unpublished
F. rosea	ATCC 76767	DQ491410	DQ491410	Kim & al. 2007
Fragiliporia fragilis	Dai 13080	KJ734260	KJ734264	Zhao & al. 2015a
	Dai 13559	KJ734261	KJ734265	Zhao & al. 2015a
	Dai 13561	KJ734262	KJ734266	Zhao & al. 2015a
Ganoderma lingzhi	Wu 1006-38	JQ781858	—	Zhao & al. 2013
Gelatoporia subvermispora	BRNU 592909	FJ496694	FJ496706	Tomšovský & al. 2010
Gloeoporus dichrous	KHL 11173	EU118627	EU118627	Binder & al. 2005
G. pannocinctus	BRNM 709972	EU546099	FJ496708	Tomšovský & al. 2010
Grammothelopsis subtropica	Cui 9041	JQ845094	JQ845099	Zhao & al. 2013
Heterobasidion annosum	PFC 5252	KC492906	KC492906	Binder & al. 2013
Hornodermoporus martius	MUCL 41677	FJ411092	FJ393859	Robledo & al. 2009
Hydnophlebia chrysorhiza	FD-282	KP135338	KP135216	Floudas & Hibbett 2015
Hypochnicium lyndoniae	NL 041031	JX124704	JX124704	Unpublished
Junghuhnia nitida	KHL 11903	EU118638	EU118638	Binder & al. 2005
Obba rivulosa	KCTC 6892	FJ496693	FJ496710	Miettinen & Rajchenberg 2012
O. valdiviana	FF 503	HQ659235	HQ659235	Miettinen & Rajchenberg 2012
Phanerochaete chrysosporium	BKM-F-1767	HQ188436	GQ470643	Wu & al. 2010
P. velutina	HHB-15343	KP135184	—	Floudas & Hibbett 2015
Perenniporia medulla-panis	MUCL 49581	FJ411087	FJ393875	Robledo & al. 2009
Perenniporiella neofulva	MUCL 45091	FJ411080	FJ393852	Robledo & al. 2009
Phlebia acanthocystis	FP 150571	KY948767	KY948844	Justo & al. 2017
P. acerina	FD-301	KP135378	KP135378	Justo & al. 2017
	HHB-11146	KP135372	—	Floudas & Hibbett 2015
	FP-135252	KP135371	—	Floudas & Hibbett 2015
	DR-60	KP135375	KF691615	Floudas & Hibbett 2015

Table 1, continued on next page

Table 1, continued

Species name	Sample no.	GenBank accession no.		References
		ITS	LSU	
P. ailaoshanensis	CLZhao 3996	MH784926	MH784936	Shen & al. 2018
	CLZhao 4036	MH784927	MH784937	Shen & al. 2018
P. aurea	DLL 2011-100	KJ140614	—	Unpublished
	FCUG 2767	HQ153409	HQ153409	Binder & al. 2013
	NH-14434	AY463445	AY586691	Larsson & al. 2004
	RLG-5075	KY948759	KY948918	Justo & al. 2017
P. centrifuga	HHB-9239	KP135380	KP135262	Floudas & Hibbett 2015
	L-15541	KP135381	—	Floudas & Hibbett 2015
	GB-1013	KP135379	—	Floudas & Hibbett 2015
P. chrysocreas	HHB-6333	KP135358	KP135263	Floudas & Hibbett 2015
	HHB 3946	KP135357	AY586695	Floudas & Hibbett 2015
	FP-102161	AY219367	—	Binder & al. 2005
	KUC 20121123-24	KJ668482	KJ668335	Floudas & Hibbett 2015
P. floridensis	HHB-9905	KP135383	KP135264	Justo & al. 2017
	HHB-6466	KP135385	—	Floudas & Hibbett 2015
	HHB-7175	KP135384	—	Floudas & Hibbett 2015
	FP-102562-T	KP135386	—	Floudas & Hibbett 2015
P. fuscoatra	HHB-10782	KP135364	KP135265	Floudas & Hibbett 2015
≡ *Mycoacia fuscoatra*	HHB 15354T	KP135367	KP135363	Floudas & Hibbett 2015
	HHB 18642	KP135366	—	Floudas & Hibbett 2015
	FP-102173	KP135364	—	Floudas & Hibbett 2015
	KHL 13275	JN649352	JN649352	Tomšovský & al. 2010
P. hydnoidea	HHB-1993	KY948778	KY948853	Justo & al. 2017
P. lindtneri	GB-501	KY948772	KY948847	Justo & al. 2017
P. livida	FCUG 2189	AF141624	AF141624	Tomšovský & al. 2010
P. ludoviciana	FD-427	KP135342	—	Floudas & Hibbett 2015
P. nantahaliensis	HHB-2816	KY948777	KY948852	Justo & al. 2017
P. nothofagi	HHB-4273	KP135369	KP135266	Floudas & Hibbett 2015
≡ *Mycoacia nothofagi*	HHB-6906	KP135368	—	Floudas & Hibbett 2015
	HHB-12067	KP135370	—	Floudas & Hibbett 2015
	KHL 13750	GU480000	GU480000	Tomšovský & al. 2010
P. radiata	UBCF 19726	HQ604797	HQ604797	Binder & al. 2013
	AFTOL-ID 484	AY854087	AF287885	Binder & al. 2005
	FD-85	KP135377	KP135377	Justo & al. 2017
	FD-121	KP135376	—	Floudas & Hibbett 2015
P. rufa	HHB-14924	KP135374	KX065989	Floudas & Hibbett 2015
P. setulosa	HHB-6891	KP135382	KP135267	Justo & al. 2017
	AH 31879	GQ259417	GQ259417	Binder & al. 2005
	PH 11749	GU461312	—	Binder & al. 2005
P. subochracea	HHB 8715	KY948770	KY948846	Floudas & Hibbett 2015
P. subserialis	FCUG 1434	AF141631	AF141631	Tomšovský & al. 2010
P. uda	FP-101544	KP135361	KP135232	Floudas & Hibbett 2015
	FCUG 2452	AF141614	—	Unpublished
	USDA Kropp-1	AB084621	—	Suhara & al. 2002
P. wuliangshanensis	**CLZhao 3475 T**	MK881787	MK881897	Present study
	CLZhao 3639	MK881788	MK881898	Present study
	CLZhao 3645	MK881789	MK881899	Present study

Table 1, concluded

Species name	Sample no.	GenBank accession no.		References
		ITS	LSU	
Piloporia sajanensis	Mannine 2733a	HQ659239	HQ659239	Tomšovský & al. 2010
Podoscypha venustula	CBS 65684	JN649367	JN649367	Sjoekvist & al. 2012
Polyporus tuberaster	CulTENN 10197	AF516596	AJ488116	Binder & al. 2013
Postia guttulata	KHL 11739	EU11865	EU11865	Kim & al. 2007
Pouzaroporia subrufa	BRNM 710164	FJ496661	FJ496723	Tomšovský & al. 2010
Sebipora aquosa	Miettinen 8680	HQ659240	HQ659240	Miettinen & Rajchenberg 2012
Skeletocutis amorpha	Miettinen 11038	FN907913	FN907913	Tomšovský & al. 2010
S. jelicii	H 6002113	FJ496690	FJ496727	Tomšovský & al. 2010
S. portcrosensis	LY 3493	FJ496689	FJ496689	Tomšovský & al. 2010
S. subsphaerospora	Rivoire 1048	FJ496688	FJ496688	Tomšovský & al. 2010
Steccherinum fimbriatum	KHL 11905	EU118668	EU118668	Tomšovský & al. 2010
S. ochraceum	KHL 11902	JQ031130	JQ031130	Tomšovský & al. 2010
Stereum hirsutum	NBRC 6520	AB733150	AB733325	Tomšovský & al. 2010
Truncospora ochroleuca	MUCL 39726	FJ411098	FJ393865	Robledo & al. 2009
Tyromyces chioneus	Cui 10225	KF698745	KF698756	Zhao & al. 2013
Xanthoporus syringae	Gothenburg 1488	JN710607	JN710607	Tomšovský & al. 2010

from the dried specimens and observed under light microscopy following Dai (2012). Abbreviations are: KOH = 5% potassium hydroxide, CB = Cotton Blue, CB– = acyanophilous, L = mean spore length (arithmetic average of all spores), W = mean spore width (arithmetic average of all spores), Q = variation in the L/W ratios among the specimens studied, n (a/b) = number of spores (a) measured from given number (b) of specimens.

We extracted genomic DNA from dried specimens using HiPure Fungal DNA Mini Kit II (Magen Biotech Co.) according to the manufacturer's instructions with some modifications. A small piece (c. 30 mg) of dried fungal material was ground to powder with liquid nitrogen. The powder was transferred to a 1.5 ml centrifuge tube, suspended in 0.4 ml of lysis buffer, and incubated in a 65 °C water bath for 60 min, after which 0.4 ml phenol-chloroform (24:1) was added to each tube and the suspension was shaken vigorously. After centrifugation at 13,000 rpm for 5 min, 0.3 ml supernatant was transferred to a new tube and mixed with 0.45 ml binding buffer. The mixture was then transferred to an adsorbing column (AC) for centrifugation at 13,000 rpm for 0.5 min. Then, 0.5 ml inhibitor removal fluid was added in AC for centrifugation at 12,000 rpm for 0.5 min. After washing twice with 0.5 ml washing buffer, the AC was transferred to a clean centrifuge tube, and 100 ml elution buffer was added to the middle of adsorbed film to elute the genomic DNA. The ITS region was amplified with primer pairs ITS5 and ITS4 (White & al. 1990). Nuclear LSU region was amplified with primer pairs LR0R and LR7 (Vilgalys 2018). The ITS was amplified by initial denaturation at 95 °C for 3 min, followed by 35 cycles at 94 °C for 40 s, 58 °C for 45 s, and 72 °C for 1 min, and a final extension of 72 °C for 10 min. The nLSU was amplified by initial denaturation at 94 °C for 1 min, followed by 35 cycles at 94 °C for

30 s, 48 °C 1 min, and 72 °C for 1.5 min, and a final extension of 72 °C for 10 min. The PCR products were purified and directly sequenced at Kunming Tsingke Biological Technology Limited Company. All newly generated sequences were deposited in GenBank (Table 1).

DNA sequences were edited using Sequencher 4.6. Sequences were aligned in MAFFT 7 (Katoh & Toh, 2008) using the "G-INS-I" strategy and manually adjusted in BioEdit (Hall 1999). The sequence alignment (ID 24249) was deposited in TreeBase. In Fig. 1, *Heterobasidion annosum* (Fr.) Bref. and *Stereum hirsutum* (Willd.) Pers. were used as outgroup to root the tree following Binder & al. (2013). In Fig. 2, *Hydnophlebia chrysorhiza* (Eaton) Parmasto and *Phanerochaete velutina* (DC.) P. Karst. were used as outgroup to root the tree following Floudas & Hibbett (2015).

Phylogenetic analyses of the ITS+nLSU sequences were performed using maximum parsimony, maximum likelihood, and Bayesian inference methods. Maximum parsimony (MP) analyses followed Zhao & Wu (2017), and tree construction was performed in PAUP* version 4.0b10 (Swofford 2002). All characters were equally weighted and gaps were treated as missing data. Trees were inferred using the heuristic search option with TBR branch swapping and 1000 random sequence additions. Max-trees were set to 5000, branches of zero length were collapsed and all parsimonious trees were saved. Clade robustness was assessed using bootstrap (BP) analysis with 1,000 replicates (Felsenstein 1985). Tree statistics tree length (TL), consistency index (CI), retention index (RI), rescaled consistency index (RC), and homoplasy index (HI) were calculated for each Maximum Parsimonious Tree generated. Sequences were analyzed using Maximum Likelihood (ML) with RAxML-HPC2 through the Cipres Science Gateway (Miller & al. 2009). Branch support (BS) for ML analysis was determined by 1000 bootstrap replicates.

MrModeltest 2.3 (Posada & Crandall 1998; Nylander 2004) was used to determine the best-fit evolution model for each data set for Bayesian inference (BI). Bayesian inference was calculated with MrBayes_3.1.2 using a general time reversible (GTR+G) model of DNA substitution and a gamma distribution rate variation across sites (Ronquist & Huelsenbeck 2003). Four Markov chains were run for 2 runs from random starting trees for 8 million generations (ITS+nLSU) in Fig. 1, for 5 million generations (ITS+LSU) in Fig. 2 and trees were sampled every 100 generations. The first 25% of the generations were discarded as burn-in. A majority rule consensus tree of all remaining trees was calculated. Branches that received bootstrap support for maximum likelihood (BS), maximum parsimony (BP) and Bayesian posterior probabilities (BPP) greater than or equal to 75 % (BP) and 0.95 (BPP) were considered significantly supported, respectively.

Molecular phylogeny

The first ITS+nLSU dataset (Fig. 1) included sequences from 57 fungal specimens representing 49 species of *Polyporales* plus the outgroup had an aligned length of 2104 characters, of which 1236 characters were constant, 248 variable and parsimony-uninformative, and 620 parsimony-informative.

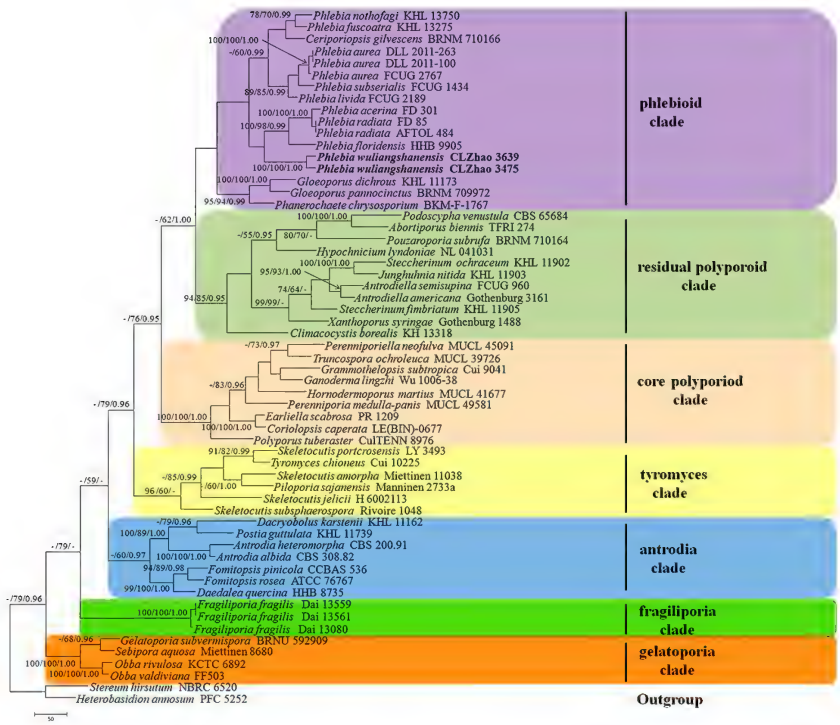

FIG. 1. Maximum Parsimony strict consensus tree illustrating the phylogeny of *Phlebia wuliangshanensis* and related species in *Polyporales* based on ITS+nLSU sequences. Branches are labeled with maximum likelihood bootstrap >70%, parsimony bootstrap proportions >50% and Bayesian posterior probabilities >0.95. Clade names follow Binder & al. (2013).

Maximum parsimony analysis yielded 3 equally parsimonious trees (TL = 4783, CI = 0.307, HI = 0.693, RI = 0.526, RC = 0.162). Best model for this dataset estimated and applied in the Bayesian analysis: GTR+I+G, lset nst = 6, rates = invgamma; prset statefreqpr = dirichlet (1,1,1,1). Bayesian analysis and ML analysis produced a similar topology as MP analysis (average standard deviation of split frequencies = 0.003241 (BI). The tree clustered the 57 polypore species into seven major clades, placing our new species, *Phlebia wuliangshanensis*, in the phlebioid clade (FIG. 1).

The second ITS+nLSU dataset (FIG. 2) comprising sequences from 51 fungal specimens representing 22 *Phlebia* species plus the outgroup had an aligned length of 2102 characters, of which 1588 characters were constant, 142 variable

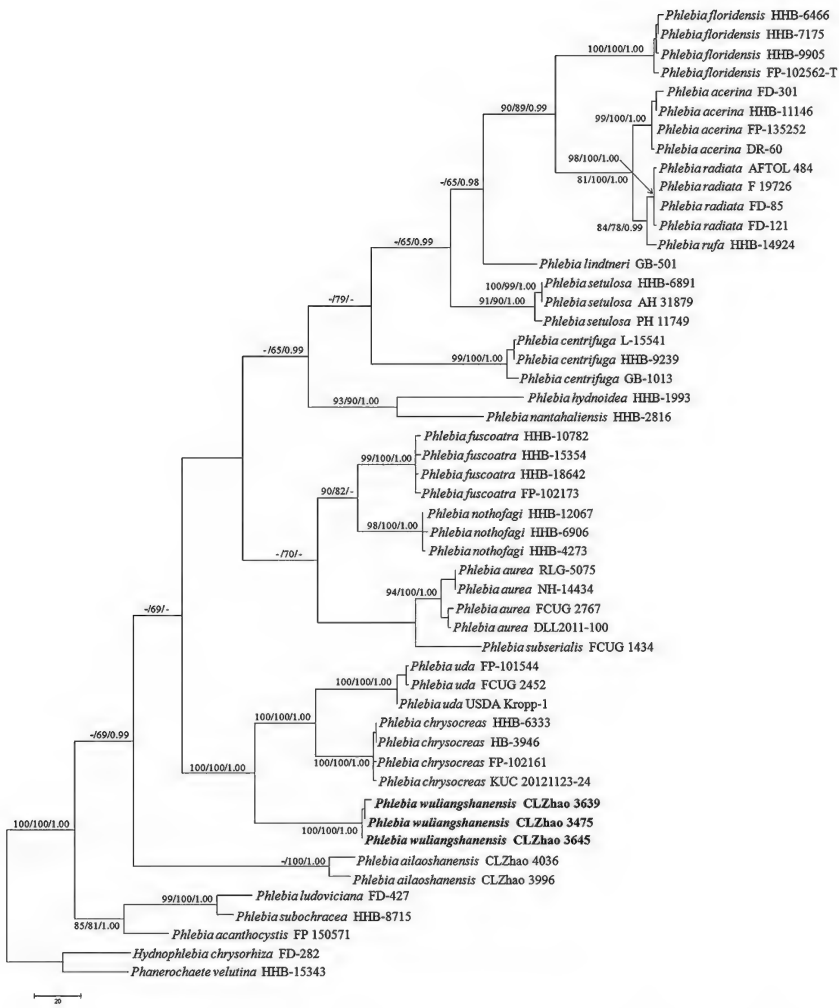

FIG. 2. Maximum parsimony strict consensus tree illustrating the phylogeny of *Phlebia wuliangshanensis* and related species in *Phlebia* based on ITS+nLSU sequences. Branches are labeled with maximum likelihood bootstrap >70%, parsimony bootstrap proportions >50% and Bayesian posterior probabilities >0.95.

and parsimony-uninformative, and 372 parsimony-informative. Maximum parsimony analysis yielded 10 equally parsimonious trees (TL = 1113, CI = 0.518, HI = 0.482, RI = 0.873, RC = 0.403). Best model for the ITS+nLSU dataset estimated and applied in the Bayesian analysis: GTR+I+G, lset nst = 6,

rates = invgamma; prset statefreqpr = dirichlet (1,1,1,1). Here also Bayesian analysis and ML analysis generated a similar topology as MP analysis (average standard deviation of split frequencies = 0.002221 (BI). The phylogeny (Fig. 2) inferred from the combined ITS+nLSU sequences from 49 *Phlebia* isolates grouped the new species with *P. chrysocreas* (Berk. & M.A. Curtis) Burds. and *P. uda* (Fr.) Nakasone.

Taxonomy

Fig. 3. *Phlebia wuliangshanensis* (holotype, SWFC 003475). Scale bar = 1 cm.

Phlebia wuliangshanensis C.L. Zhao, **sp. nov.** Figs 3, 4

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Differs from *Phlebia chrysocreas* by its narrower ellipsoid basidiospores and from *P. uda* by its smooth to tuberculate hymenium and generative hyphae with simple septa.

Type: China. Yunnan Province: Puer, Jingdong County, Wuliangshan National Nature Reserve, on angiosperm trunk, 2 October 2017, CLZhao 3475 (**Holotype**, SWFC 003475; GenBank MK881787, MK881897).

Etymology: The specific epithet *wuliangshanensis* (Lat.) refers to the locality (Wuliangshan) of the type specimen.

Basidiomata annual, resupinate, easily separable from the substratum, ceraceous to gelatinous, without odor or taste when fresh, becoming membranaceous upon drying, ≤12 cm long, 200–700 μm thick. Hymenial

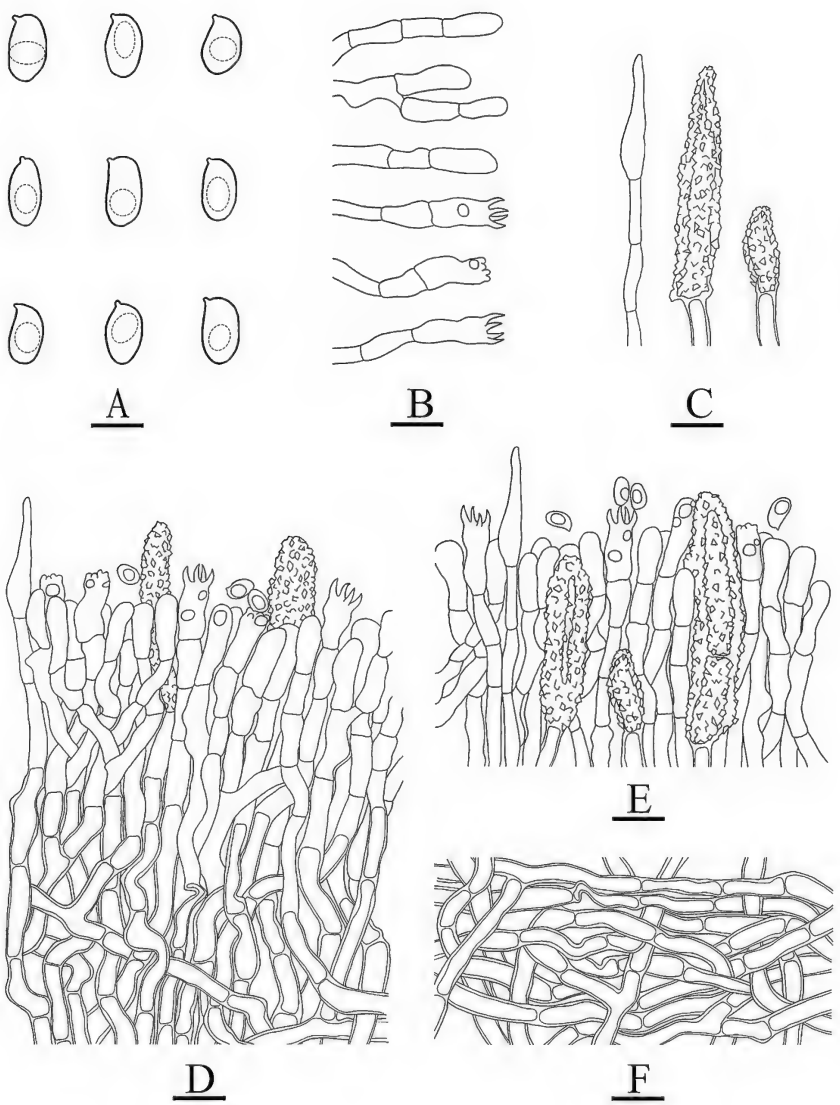

Fig. 4. Microscopic structures of *Phlebia wuliangshanensis* (drawn from the holotype, SWFC 003475). A. Basidiospores; B. Basidia and basidioles; C. Cystidia; D. Basidiocarp section; E. Hymenium section; F. Hyphae from subiculum. Scale bars: A = 5 μm; B–F = 10 μm.

surface smooth to tuberculate, white to cream to pale brown when fresh, cream to pale brown upon drying. Sterile margin distinct, white.

Hyphal structure monomitic; generative hyphae with simple septa, negative in Melzer's reagent, CB–; tissues unchanged in KOH.

Subiculum generative hyphae hyaline, thin- to thick-walled, branched, 3–5.5 µm in diam.

Hymenium cystidia of two kinds: 1) hyaline, cylindrical, numerous, thick-walled, strongly encrusted, 20–55 × 6–10.5 µm; 2) hyaline, lanceolate, few, thin-walled, 12–18 × 3–4.5 µm; basidia barrel-shaped, with four sterigmata and a simple basal septum, 10–16 × 4–5 µm; basidioles dominant, in shape similar to basidia, but slightly smaller.

Basidiospores narrowly ellipsoid to ellipsoid, more or less curved, hyaline, thin-walled, smooth, negative in Melzer's reagent, CB–, 5–6(–6.5) × 3–3.7 µm, L = 5.42 µm, W = 3.32 µm, Q = 1.64–1.73 (n = 180/3).

Type of rot: white.

Additional specimens examined: **CHINA. Yunnan province. Puer:** Jingdong County, Wuliangshan National Nature Reserve, on angiosperm trunk, 2 October 2017, CLZhao 3639 (SWFC 003639; GenBank MK881788, MK881898), CLZhao 3645 (SWFC 003645; GenBank MK881789, MK881899).

Discussion

We describe a new species, *Phlebia wuliangshanensis*, based on phylogenetic analyses and morphological characters.

Previously, seven clades were found in *Polyporales*: /antrodia, /core polyporoid, /fragiliporia, /gelatoporia, /phlebioid, /residual polyporoid, and /tyromyces (Binder & al. 2013, Zhao & al. 2015). Our combined ITS+nLSU sequence analysis (Fig. 1) strongly supports *Phlebia wuliangshanensis* (100% BS, 100% BP, 1.00 BPP) within the phlebioid clade and related to the type species, *P. radiata*.

Phlebia wuliangshanensis is closely related to *P. chrysocreas* and *P. uda* in the ITS+nLSU phylogenetic tree (Fig. 2). Morphologically, *P. chrysocreas* differs from *P. wuliangshanensis* by having ochraceous-buff to yellow ochre color hymenophore and narrowly ovoid basidiospores (4–6 × 2–2.5 µm, Lombard & al. 1975), while *P. uda* presents an odontoid hymenophore, generative hyphae bearing clamp connections, and smaller basidiospores (5–5.5 × 2–2.5 µm, Bernicchia & Gorjón 2010).

Phlebia wuliangshanensis morphologically resembles other *Phlebia* species: *P. bispora* (Stalpers) Nakasone, *P. capitata* Bernicchia & Gorjón, *P. coccineofulva* Schwein., *P. femsjoeensis* (Litsch. & S. Lundell) J. Erikss.

& Hjortstam, *P. livida* (Pers.) Bres., *P. nothofagi* (G. Cunn.) Nakasone, *P. radiata*, *P. rufa* (Pers.) M.P. Christ., *P. segregata* (Bourdot & Galzin) Parmasto, and *P. subserialis* (Bourdot & Galzin) Donk. These species differ from *P. wuliangshanensis* as follows: *P. bispora* by a hydnoid hymenophore, dimitic hyphal system, and smaller basidiospores (4–5 × 2.5–3 µm, Nakasone 2002); *P. capitata* by an odontoid hymenophore, generative hyphae with clamps, and the presence of capitate cystidia (Bernicchia & Gorjón 2010); *P. coccineofulva* by a granular hymenophore with vivid yellow radiating margin and metuloid cystidia (Schweinitz 1832); *P. femsjoeensis* by orange to violaceous basidiocarps (Eriksson & al. 1981); *P. livida* by its reddish hymenophore and a monomitic hyphal system with generative hyphae with clamps (Bernicchia & Gorjón 2010); *P. nothofagi* by effused basidiocarps with a hydnoid hymenophore, a monomitic hyphal system with generative hyphae with clamps, and narrower basidiospores (4–6 × 2–3 µm, Nakasone 1997); *P. rufa* by its effused basidiocarps with the reticulate or subporoid hymenophore (Christiansen 1960); *P. segregata* by its smooth hymenophore and cylindrical basidiospores (6–7 × 2–2.5 µm, Parmasto 1967); and *P. subserialis* by a white hymenium, clamped generative hyphae, and allantoid basidiospores (6–7 × 1.5–2 µm, Bernicchia & Gorjón 2010).

Although wood-rotting fungi are an extensively studied group in *Basidiomycota* (Gilbertson & Ryvarden 1987, Núñez & Ryvarden 2001, Bernicchia & Gorjón 2010, Dai 2012, Ryvarden & Melo 2014, Dai & al. 2015), Chinese wood-rotting fungi diversity is still not well known, especially in the subtropics and tropics. The new species *Phlebia wuliangshanensis* is from the Chinese subtropics, where many new taxa in the *Polyporales* have been described (Cui & al. 2007, 2009, 2010, 2011; Cui & Dai 2008; Du & Cui 2009; Li & Cui 2010; He & Li 2011; Jia & Cui 2011; Yu & al. 2013; Yang & He 2014; Chen & al. 2015; Zhao & Wu 2017; Zhao & Ma 2019). We anticipate that more new polypore taxa will be found in China after further investigations and molecular analyses.

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Pseudocercospora seropedicensis & *P. solani-cernui* spp. nov. on *Solanum* from Brazil

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Abstract—Using stereo- and light microscopy, two leaf-spotting cercosporoid fungi, collected from areas of the Brazilian Atlantic Forest in the states of Minas Gerais and Rio de Janeiro, were shown to represent two new species (*Pseudocercospora seropedicensis* on *Solanum asperum* and *P. solani-cernui* on *S. cernuum*), which are herein described and illustrated.

Key words—cercosporoid fungi, hyphomycetes, morphology, mycodiversity, *Solanaceae*

Introduction

Cercosporoid fungi, which are found worldwide, are especially abundant and diverse in tropical and subtropical areas of Africa, Asia, Australia, and Central and South America (Beilharz 2002; Braun & Freire 2003, 2004, 2006; Castañeda & Braun 1989; Hernández-Gutiérrez & Dianese 2008, 2009; Inácio & al. 1996; Silva & al. 2016). These fungi have been studied by several authors in Brazil (Batista & al., cf. Silva & Minter 1995; Braun & Freire 2004; Chupp 1954; Crous & Braun 2003; Crous & Wingfield 1997; Crous & al. 1999; Fernandes & al. 2013; Hernández-Gutiérrez & Dianese 2008, 2009; Hernández-Gutiérrez & al. 2014, 2015; Inácio & Dianese 1998, 1999, 2006; Inácio & al. 1996; Pereira & Barreto 2006; Silva & al. 2016; Viégas 1945). They have been reported as plant pathogens on several hosts including different economically important crops,

and some cercosporoid fungi are also used for biological control of weeds (Farr & Rossman 2019, Groenewald & al. 2013, Hanada & Gasparotto 2002, Mendes & Urben 2019, Mendes & al. 1998, Pereira & Barreto 2006, Pons 1987, Spegazzini 1910).

Pseudocercospora Speg. (introduced by Spegazzini 1910 for the type species *P. vitis* (Lév.) Speg.) contains endophytic, pathogenic, or saprotrophic species, some of which are used for weed control (Breeÿen & al. 2006). The genus now comprises synnematal fungi previously assigned to *Phaeoisariopsis* Ferraris (Ferraris 1909) and fungi with slightly pigmented conidiogenous structures and with paracercospora-like *loci*, although most *Pseudocercospora* species are characterized by unthickened, non-pigmented conidiogenous loci and conidial hila (Braun 1995, Deighton 1976). Sexual morphs are unknown for most species, but when present they are mycosphaerella-like, previously allocated in *Mycosphaerella,* now a heterotypic synonym of *Ramularia* Unger (Braun & al. 2013, Crous & al. 2013).

Solanaceae comprises about 3000 species in 150 genera, distributed primarily in tropical and subtropical South America. In Brazil there are 350 species in 32 genera (Souza & Lorenzi 2008). *Solanum,* the most abundant genus, encompasses about 1500 species and occurs in tropical and subtropical areas worldwide (Sarmento-Silva & al. 2003). Several economically important species also belong in *Solanaceae:* pepper (*Capsicum*), potato (*Solanum tuberosum*), tomato (*S. lycopersicum*), and tobacco (*Nicotiana tabacum*) (Martins & Costa 1999). Cercosporoid fungi occur on *Solanum* species (Silva & al. 2016), and recently Braun (2017) published an identification key for *Pseudocercospora* species on *Solanum* hosts with descriptions and illustrations for some species.

Here we describe and illustrate two new *Pseudocercospora* species found on leaves of *Solanum asperum* and *S. cernuum*.

Materials & methods

Plant material showing necrotic leaf spots was collected during July 2013–October 2017 in the States of Rio de Janeiro (UFRRJ campus in Paracambi Natural Park and the National Forest in Seropédica) and Minas Gerais (town of Liberdade).

Fresh and dried symptomatic leaves were examined with a dissecting microscope to select fungal structures for mounting on slides with Cotton Blue / lactoglycerol or phloxine / KOH glycerol. Material was also hand-sectioned and mounted on slides. Tissues were microscopically observed and photographed using an Olympus BX41 light microscope coupled to a Canon Power Shot ELPH 100 HS camera. Structures were measured using a calibrated ocular micrometer. The exsiccates were registered and deposited in the Plant Pathological Herbarium "Verlande Duarte Silveira" at the Rural University of Rio de Janeiro (UFRJ).

Table 1. Selected *Pseudocercospora* species on *Solanum*

Species	Hosts	Distribution	References
P. atromarginalis	*Solanum* spp., *S. americanum*, *S. lycopersicum*	Cuba, Taiwan, Korea, USA	Atkinson (1892), Castañeda & Braun (1989), Choi et al. (2015), Deighton (1976), Guo & Hsieh (1995)
P. marcelliana	*S. nudum*, *S. torvum* var. *hartwegianum*, *S. micranthum*	Spain, Venezuela	Chupp (1954), Crous & Braun (2003), Braun (2017)
P. seropedicensis	*S. asperum*	Brazil	**This work**
P. solani-cernui	*S. cernuum*	Brazil	**This work**
P. solani-pseudocapsicicola	*S. pseudocapsicum*	Brazil	Silva et al. (2016)
P. solani-torvicula	*S. torvum*	Taiwan	Guo & Hsieh (1995)
P. trichophila var. *trichophila*	*Solanum* spp.	Asia, Central and South America, North America, Oceania	Stevens (1917), Chupp (1954), Braun (2017)
P. trichophila var. *punctata*	*S. hirtum*	Venezuela	Braun & Urtiaga (2012)
P. venezuelae	*Solanum* sp., *S. argenteum*, *S. "aculeatum"*, *S. aethiopicum* [= *S. gilo*]	Brazil, Venezuela, South America	Chupp (1954), Crous & Braun (2003), Braun & Freire (2003; 2006), Braun (2017)

Taxonomy

Pseudocercospora seropedicensis Andrade, Medeiros & Inácio, **sp. nov.** Pl. 1

MB 819383

Differs from *Pseudocercospora solani-asperi* [≡ *P. trichophila* var. *trichophila*] by its much longer conidia and conidiophores and its larger, amphigenous. stromata.

Type: Brazil, Rio de Janeiro, Seropédica, road to cattle farm, near Instituto de Florestas, 22°45′31″S 43°41′57″W, on leaves of *Solanum asperum* Rich. (*Solanaceae*), 07 May 2016, C. A. Inácio 122, (**Holotype**, UFRJ 12.390).

Etymology: honoring the municipality, Seropédica, where the species was first discovered.

Lesions ≤50 mm diam., epiphyllous, sparse, sometimes gregarious, confluent, circular to irregular, reddish brown to light brown in the center, later becoming necrotic, grayish, with dark brown border. Colonies amphigenous, mainly hypophyllous, caespitose, sparse. Superficial mycelium colorless to pale brown, septate, branched, amphigenous, mostly hypophyllous, sometimes emerging through the stomata, bearing conidiophores; hyphae 2–4(–7) µm

diam.; CONIDIOPHORES 5–42(–45) × 3–4 µm, 1-septate, sometimes curved, slightly geniculate due to sympodial proliferation, not branched, borne terminally or (usually) laterally on superficial hyphae, olive to olive brown, rounded at apex. INTERNAL MYCELIUM colorless to olivaceous brown or pale brown, septate, branched, penetrating deep into the mesophyll and spreading through leaf tissue; hyphae 2–5(–6) µm diam. STROMATA 25–80(–85) × 20–140(–160) µm, brown, amphigenous, subepidermal, erumpent, textura angularis; cells 4–7 µm wide, giving rise to a fascicle of conidiophores; CONIDIOPHORES 20–70 × 1–4 µm, 1–5-septate, numerous, macronematous, mononematous, olive to olive brownish, smooth, densely caespitose, arising from stromata, straight or slightly sinuous. CONIDIOGENOUS CELLS integrated, polyblastic, usually monoblastic and terminal, sympodial, geniculate, with inconspicuous conidiogenous loci. CONIDIA solitary, 20–145(–226) × 2–6 µm, 1–16-septate, straight, sometimes sinuous to curved, subcylindrical to obclavate, smooth, hyaline, subhyaline to olivaceous brown, attenuated at apex, obconically truncate at base, hila neither thickened not darkened, 1–2 µm wide.

COMMENTS—Several *Pseudocercospora* species on solanaceous hosts are morphologically close to *P. seropedicensis*. *Pseudocercospora atromarginalis* (G.F. Atk.) Deighton (Deighton 1976), *P. marcelliana* (Chupp) U. Braun & Crous (Crous & Braun 2003; Braun 2017), *P. solani-torvicola* Goh & W.H. Hsieh, *P. trichophila* var. *trichophila* (F. Stevens) U. Braun [as *P. solani-asperi* (R.E.D. Baker & & W.T. Dale) Deighton] (Stevens 1917; Baker & Dale 1951; Chupp 1954; Deighton 1976; Crous & Braun 2003; Braun 2017), *P. trichophila* var. *punctata* U. Braun & Urtiaga, *P. venezuelae* (Chupp) Deighton, and *P. solani-pseudocapsicicola* Meir. Silva & al. are compared in TABLES 1–2. *Pseudocercospora atromarginalis* lacks superficial mycelia with secondary conidiophores; collections from Taiwan with conidiophores (10–65 × 3–5 µm/0–4-septa) and close to our specimen differed in lacking stromata (Guo & Hsieh 1995, Choi & al. 2015). *Pseudocercospora marcelliana* differs by shorter conidia (15–70 µm) and conidiophores (5–25 µm), an absence of superficial mycelium, and occurrence on other hosts or in different locations (Braun 2017; Crous & Braun 2003; Chupp 1954, as *Cercospora*). *Pseudocercospora venezuelae* differs by shorter conidiophores (10–70 µm), conidia (15–)30–65 µm), and lacks superficial mycelium; and *P. solani-torvicola* differs by smaller (≤30 µm) stromata, shorter and wider primary conidiophores (35–60 × 4.0–5.5 µm), shorter secondary conidiophores (10–25 µm), and shorter conidia (20–115 µm) with fewer septa (1–11).

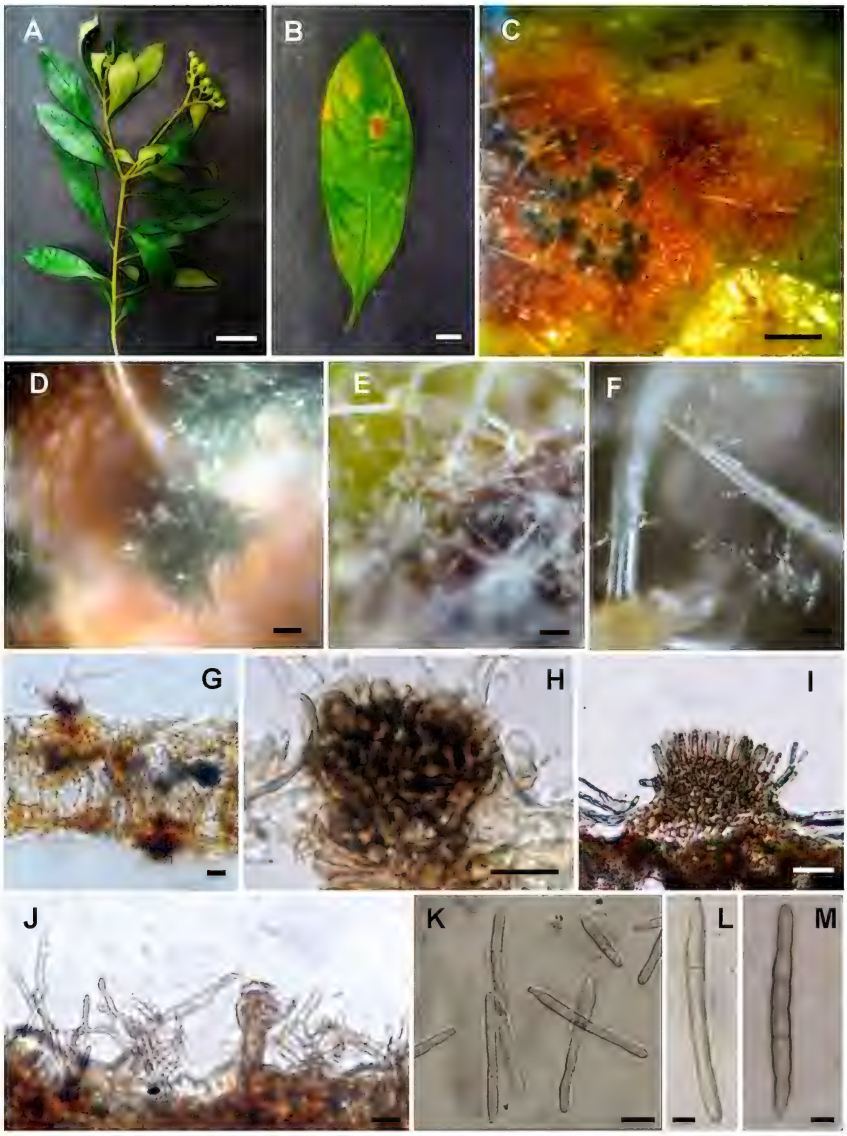

Plate 1. *Pseudocercospora seropedicensis* (holotype, UFRJ 12.390) on leaves of *Solanum asperum*. A. Branch of *S. asperum*. B. Leaf with lesions. C. Detail of fructifications on lesions. D–F. Conidiophores and conidia as seen under dissecting microscope. G–I. Stroma (vertical section). J. Secondary mycelia on leaf undersurface. K–M. Conidia. Scale bars: A = 5 cm; B = 1 cm; C = 1 μm; D–I = 20 μm; J, K = 10 μm; L, M = 5 μm.

Pseudocercospora trichophila var. *punctata* has smaller dark brown to blackish stromata (10–60 µm diam) (Braun 2017). Finally, although *P. solani-asperi* [≡ *P. trichophila* var. *trichophila*] (Braun 2017) has been reported in Brazil on the same host species (Chupp 1954 as *Cercospora solani-asperi,* Crous & Braun 2003, Deighton 1976 as *Pseudocercospora solani-asperi,* Fernandes & al. 2013), it produces shorter 20–110(165) conidia with fewer 1–10(15) septa; *P. solani-asperi* also usually shows hypophyllous caespituli and lacks a stroma, clearly distinguishing it from the new species found now in the Atlantic Forest. *Pseudocercospora solani-pseudocapsicicola*, a new species recently reported on leaves of *Solanum pseudocapsicum* from Brazil (Silva & al. 2016), clearly differs in lacking stromata, shorter (42–128 µm) conidia with fewer (2–6) septa, and hypophyllous conidiophores.

Pseudocercospora seropedicensis is the first report of a *Pseudocercospora* species on leaves of *Solanum asperum* in the State of Rio de Janeiro and the second in Brazil.

Additional specimens examined—**BRAZIL. Rio de Janeiro: Paracambi,** Parque Natural Municipal do Curió, 22°35′44″S 43°42′18″W, 9.XII.2013, C. A. Inácio 61, (UFRJ 12015); 19.III.2014, C. A. Inácio 74 (UFRJ 12050). **Seropédica**, Campus UFRRJ, Jardim Botânico near the road to Agricultural Institute, 22°45′53″S 43°41′35″W, 11.VIII.2017, J. M. Oliveira 32 (UFRJ 12.495); 11.VIII.2017, J. D. Almeida 03 (UFRJ 12.496); near Bus Station in front of Female Students Dormitory, 22°45′59″S 43°41′24″W, 22.IX.2017, J. Rembinski 35, J. (UFRJ 12.594); National Forest (Fiona), 22°43′46″S 43°42′36″W, 29.VI.2013, C. A. Inácio 79 (UFRJ 12064).

Pseudocercospora solani-cernui Rembinski, Oliveira & Inácio, **sp. nov.** Pl. 2

MB 824359

Differs from *P. seropedicensis* by its narrower conidiophores, its larger stromata, and its lack of secondary mycelium.

Type: Brazil, Minas Gerais, Liberdade, Sítio Carcará, Zona Rural, Bairro Taquaruçú–Rodovia Joanito Balieiro Km 9, 22°04′26″S 44°23′48″W, on leaves of *Solanum cernuum* Vell. *(Solanaceae)*; 14.Oct. 2016, J.C. Oliveira 29 (**Holotype**, UFRJ 12.422).

Etymology: referring to the host species, *Solanum cernuum*.

Lesions ≤25 mm diam., amphigenous, mainly epiphyllous, sparse, sometimes confluent, circular, later irregular, initially visible as yellowish spots becoming reddish brown to light brown or grayish brown in the center with yellowish margin at the adaxial face and shown as pale areas

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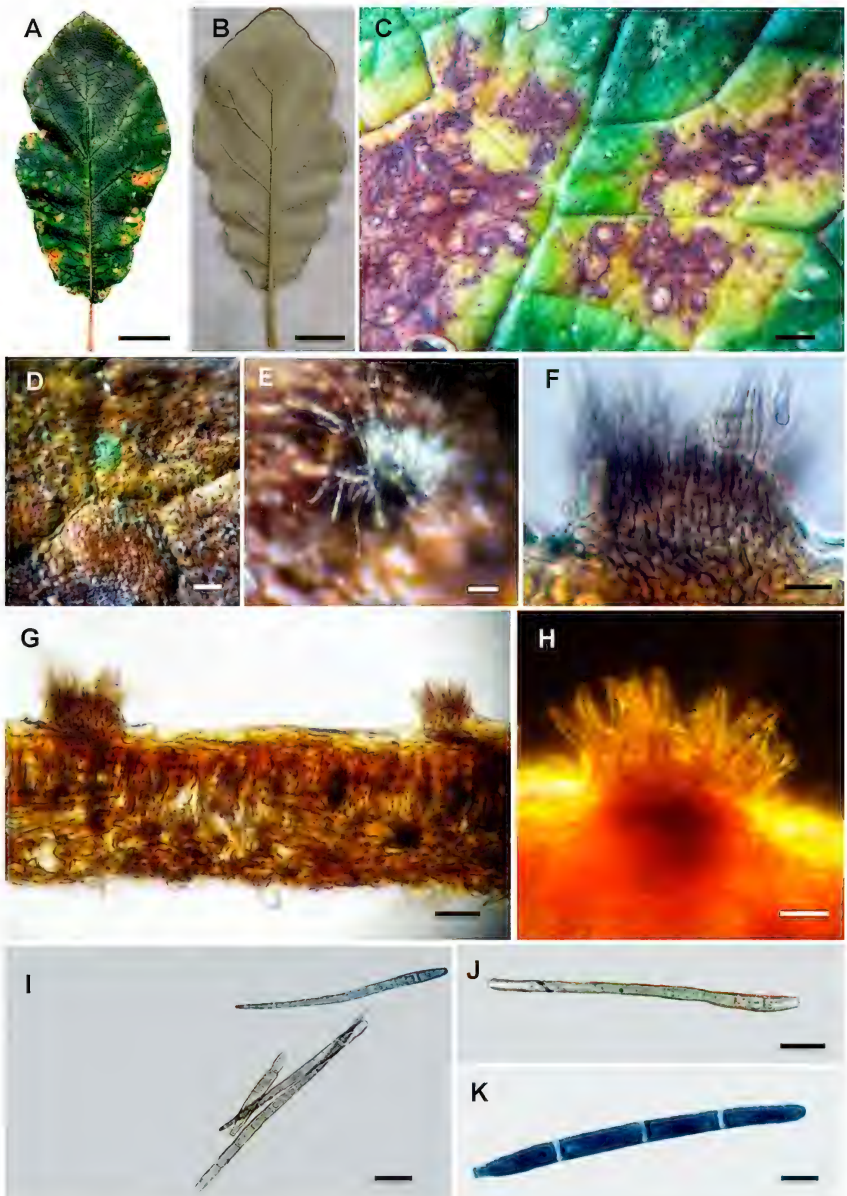
Plate 2. *Pseudocercospora solani-cernui* (holotype, UFRJ 12.286) on leaves of *Solanum cernuum*. A, B. Affected leaf (A: upper surface; B: under surface). C. Leaf spots on upper surface. D. Fructifications on upper surface. E. Conidia and conidiophores seen under stereomicroscope.



F. Stroma with conidiophores showing textura angularis (vertical section). G. Stromata (vertical section). H. Stroma and conidiophores. I–K. Conidia. Scale bars: A, B = 5 cm; C = 10 mm; D = 5 mm; E, F = 20 µm; G = 50 µm; H = 5 µm; I, J =10 µm; K = 5 µm.

at the abaxial face of the leaf, becoming slightly brownish at the center, corresponding to the upper leaf spots. Colonies epiphyllous, caespitose, sparse. Mycelium: internal, colorless to pale brown, septate, branched, penetrating the mesophyll; hyphae 2–4 µm diam. Stromata 10–70 × 30–90(–150) µm, brown, epiphyllous, subepidermal, erumpent, textura angularis, with brownish angular cells; cells 4–7 µm wide, forming a fascicle of conidiophores. Conidiophores 20–46 × 3–6 µm, 1–3-septate, numerous, macronematous, mononematous, brown, smooth, densely caespitose, arising from stromata, straight or slightly sinuous. Conidiogenous cells integrated, polyblastic, mostly monoblastic and usually terminal, sympodial, geniculate, with inconspicuous conidiogenous loci. Conidia solitary, 30–145 × 2–5 µm, 2–12-septate, straight, sometimes sinuous to curved, subcylindrical to obclavate, smooth, subhyaline to brown olivaceous, attenuated at the apex, obconically truncate at the base, hila neither thickened nor darkened, 1–2 µm diam.

Table 2. Morphological comparison of selected *Pseudocercospora* species on *Solanum*

Species	Stromata (µm)	Conidiophore/ septa (µm)	Conidia (µm) / septa	References
P. atromarginalis	Absent or only a few brown cells	15–65(100) × 3–5 / 0–4	20–95 × 3.5–5 / 3–11	Guo & Hsieh (1995)
P. marcelliana	15–75	5–30 × 1.5–4 / 1-2	15–110 × 2–3.5 / (1)3–11	Braun (2017)
P. seropedicensis	25–80 (–85) × 20–140 (–160)	1′—20–70 × 1–4 / 1–5; 2′—5–42(45) × 3–5 / 0–1	20–140(226) × 2–6 / 1–16	**This work**
P. solani-cernui	10–60 × 30–90 (–150)	(15)30–46 × 2–4 / ≤3	30–145 × 2–5 / 2–12	**This work**
P. solani-pseudocapsicicola	Lacking	10–35 × 3–5 / 0–3	42–128 × 2–3.5 / 2–6	Silva et al. (2016)
P. solani-torviculaz	≤30	1′—35–60 × 4.0–5.5 / 1-3 2′—10–25 × 4–5 / 0–1	20–115 × 4.5–6 / 1–11	Guo & Hsieh (1995)
P. trichophila var. *punctata*	10–60	10–70 × 3–7 / 0–4	(10)20–90(110) × (2.5)3–5 (6) / (1)2–10(12)	Braun & Urtiaga (2012)
P. trichophila var. *trichophila*	Lacking to few swollen hyphal cells	5-80 × 2.5–5 / 0–4	20–110(165) × 3–5(7) / 1–10(15)	Braun (2017)
P. venezuelae	15–40	10–70 × 2–4 / 0–1(2)	(15–)30–65 × 3–5 / (0–)3–6	Braun (2017)

Comments—*Pseudocercospora solani-cernui* is closely related to *P. trichophila* var. *trichophila, P. solani-pseudocapsicicola,* and *P. seropedicensis* (Tables 1–2). Although showing similar conidial dimensions (20–110(165) × 3–5(–7) µm) and occurring on various *Solanum* species, *P. trichophila* var. *trichophila* is distinguished by much smaller (≤5 mm) leaf spots, absence of a stroma, and longer (45–80 µm) conidiophores (Deighton 1976). *Pseudocercospora solani-pseudocapsicicola* (reported on *S. pseudocapsicum* in Brazil) differs in lacking stromata and narrower conidia (42–128 × 2–3.5 µm) with fewer (2–6) septa (Silva & al. 2016); *P. seropedicensis* exhibits similar sized stromata ((20–)140 (–160) µm) but is clearly distinguished from the new species on *S. cernuum* by its much longer (20–60(–70) µm) conidiophores, conidia with more (1–16) septa, and superficial mycelium bearing secondary conidiophores.

The above differences morphologically support the *Pseudocercospora* specimen on *S. cernuum* as a new species, here designated as *P. solani-cernui*.

Additional specimens examined—**BRAZIL. Rio de Janeiro: Paracambi,** Parque Natural Municipal do Curió, 22°35′44″S 43°42′18″W, 05.II.2016, J.M. Oliveira 14 (UFRJ 12.271); 10.VI.2016, J.M. Oliveira 17 (UFRJ 12.290). **Seropédica,** Campus UFRRJ, reserve in front of the Instituto de Florestas UFRRJ, 22°45′30″S 43°41′54″W, 26.X.2017, C.A. Inácio 160 (UFRJ 12.553). **Minas Gerais, Liberdade**: Sítio Carcará, Zona Rural, Bairro Taquaruçú–Rodovia Joanito Balieiro Km 9, 22°04′26″S 44°23′48″W, 28.X.Oct. 2015, J.C. Oliveira 5 (UFRJ 12172).

Key to *Pseudocercospora* species on *Solanum* from Brazil

1 Mycelium internal and external 2
1′ Mycelium consistently internal 4
2 Leaf spots lacking or indistinct, stroma absent ..... ***P. trichophila* var. *trichophila***
2′ Leaf spots amphigenous, stroma well developed ..... ***P. seropedicensis***
3 Stromata lacking or small as small substomatal clumps of swollen hyphae 4
3′ Stromata well-developed; often forming sporodochial conidiomata 5
4 Conidia 42–128 µm long; on *S. pseudocapsicum* ..... ***P. solani-pseudocapsicicola***
4′ Conidia shorter (≤110(–120) µm); on *Solanum* spp. ..... ***P. atromarginalis***
5 On *Solanum cernuum;* conidia 30–145 µm long, ≤12-septate ..... ***P. solani-cernui***
5′ On *Solanum aculeatum;* conidia (15–)30–65 µm long, ≤6-septate .... ***P. venezuelae***

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The nomenclatural history of *Umbilicaria spodochroa* and nomenclatural corrections in *Umbilicariaceae*

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Abstract—The name *Umbilicaria spodochroa* is currently applied to a species with an oceanic distribution in Europe and East Asia. The upper surface of its thallus is grey to dark brown, apothecia are omphalodiscs with prominent central umbilicus-like buttons. Its designated type and other original material are referred to *U. hirsuta*. Conservation is required to retain this name in current use. The nomenclatural history of *U. spodochroa* is presented to serve as the background for its conservation. The subgeneric nomenclature of *Umbilicaria* is revised and one new name (*U.* subg. *Papillophora*) is proposed to replace the illegitimate *U.* subg. *Gyrophora*. The status of many new names published by G.F. Hoffmann in his "Deutschlands Flora" (1796) is discussed and their nomenclatural validity is supported.

Key words—conservation, Ehrhart, historical collections, Hoffmann, typification

Introduction

Species of *Umbilicariaceae* Chevall. are predominantly saxicolous lichens mostly found in regions of higher latitudes or altitudes worldwide. Multilocus phylogenies resulted in a new generic concept of the family, which currently includes three genera comprising together about one hundred species with mostly umbilicate growth habit (Bendiksby & Timdal 2013, Davydov & al. 2017).

Morphological details of the upper and lower thallus surfaces as well as traits of the rhizinomorphs were mostly taken into consideration by earlier lichenologists to distinguish species of *Umbilicaria* Hoffm. However, these characters have not always been easily recognizable. For this reason, the circumscriptions of some of the early described species have been controversially discussed. One species with a rather complicated taxonomic and nomenclatural history is *Umbilicaria spodochroa* which, in the 18th and 19th centuries, was often confused with another early described species, *U. hirsuta* (Sw.) Ach.

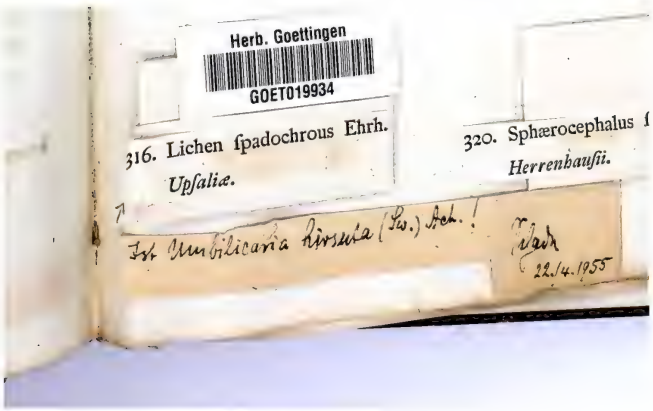
Umbilicaria spodochroa, with an oceanic distribution in Europe and East Asia (Wei & Jiang 1993), is characterized by a large thallus with a grey to dark brown upper surface and pale brown to black papillate lower surface with abundant rhizinomorphs and characteristic omphalodisc-type apothecia with prominent central umbilicus-like buttons. By such characterization, this species is easily recognizable, and specimens thereof were frequently distributed in exsiccatal series (see the list in Llano 1950).

Umbilicaria hirsuta, a Holarctic species, is characterized by producing parasoredia on the marginal part of the upper thallus surface, unlike the closely related *U. grisea* Hoffm. in which the parasoredia clump and become farinose with variously sized granules (Codogno & al. 1989). The lower surface of *U. hirsuta* is beige to almost black with sparse to abundant rhizinomorphs. Apothecia, which are rarely produced, belong to the gyrodisc type.

As currently defined (Frey 1933, Llano 1950, Codogno & al. 1989, Wei & Jiang 1993), *Umbilicaria hirsuta* and *U. grisea* can be unambiguously distinguished by their diagnostic characters as stated above. Both species names are currently accepted (Poelt & Vězda 1981, Hitch & Purvis 2009, Stenroos & al. 2016), and the species were assigned to the recently resurrected "*Umbilicaria* subg. *Gyrophora* (Ach.) Frey" (Davydov & al. 2017), which corresponds to a rather large clade of 13 phylogenetically analysed species. The core of this clade is constituted by the *Umbilicaria vellea* group, which includes *U. spodochroa* and *U. hirsuta*.

In spite of the current advances in the taxonomy of *Umbilicariaceae*, the nomenclature of several species is still to be clarified. In the present contribution we aim at unravelling the old confusion concerning the species name *Umbilicaria spodochroa*.

Figure 1. Type collection of *Umbilicaria spodochroa*, voucher from Göttingen (GOET 019934). A. printed label of Ehrhart's exsiccata; B. upper surface of thallus; C. lower surface of thallus. Photo: Marc Appelhans.


Herb. Goettingen
GOET019934
316. Lichen ſpadochrous Ehrh.
Upſaliæ.
320. Sphærocephalus
Herrenhauſii.
Umbilicaria hirsuta (Sw.) Ach.!
22./4.1955

A

B

C

Materials & methods

The protologue of *Umbilicaria spodochroa* and the relevant historical literature was examined to uncover the history and the original material of the name. Herbarium collections and high resolution digital photographs of *Umbilicaria* from GOET, H, LE, LINN, and MW were studied de visu, via online portals (https://plants.jstor.org), or provided by curators. Taxonomic literature was screened for relevant treatments.

Historical background

A species of *Umbilicaria* with the specific epithet "spodochrous" was first introduced by Ehrhart (1793), who distributed a specimen named "*Lichen spadochrous* Ehrh." among his exsiccatae (Fig. 1). The specimen was accompanied with a printed label, but no description or diagnosis of the species was provided.

The species epithet is controversial because in its original spelling it is meaningless and has long been considered linguistically erroneous (e.g., Schade 1955). Nylander (1861: 115; 1869: 11) stated that the epithet "spadochrous" seems to be a misspelling because it is apparently derived from the Greek word σποδός (cinder), meaning "ashes". Since the species epithet was incorrect, either as a typographic or orthographic error, under ICN (Shenzhen Code) Art. 60.1 its spelling may be corrected to "spodochrous," which is currently in common use.

Acharius (1794) referred Ehrhart's specimen of *Lichen* "*spadochrous*" to *L. polyrrhizos* L. This was done under a broad species concept and had no practical influence on the further taxonomy or nomenclature.

Valid publication and protologue

Hoffmann (1796) revised species of cryptogams (ferns, mosses, and lichens) known from Germany. Since the available knowledge was very uneven and several taxa were not sufficiently understood at that time, he treated the taxa differently as he explained in the Preface:

"Varietäten, Halbarten (Subspecies), auch Arten, welche ich als solche aufzuführen noch unentschlossen war, findet man entweder in Klammern ... den Anmerkungen, oder ohne Bezifferung der nächstverwandten Art beigestellt" [= Varieties, subspecies, also species that I was still undecided to list as such, are to be found either in parentheses ( ) placed with the annotations, or, without numeration, with the most closely related species] (Hoffmann 1796: [Vorbericht: 4]).

In the Index, according to our interpretation of this work, Hoffmann (1796) implicitly listed accepted names and their basionyms in italics and

synonyms in the regular font. In the taxonomic part of his work, he listed many species without numbers, yet with binomial names in the accepted genus. Several of such species were new to science. In annotations placed in brackets, Hoffmann mentioned quite a number of species names published by previous authors, with their original generic assignments. He also mentioned several varieties in these annotations, usually unnamed or under old polynomials, sometimes with previously published species names; according to the Index, such species names were listed as synonyms. Hoffmann's use of subspecies was very sparse, and we are not aware of any name that he may have applied at this rank.

Isoviita (1966) considered new names in Hoffmann's treatments of "undecided" taxa invalidly published because of the presumed absence of explicit acceptance by the author [ICN (Shenzhen Code) Art. 36.1]. Contrary to his opinion, we consider the internal evidence in Hoffmann (1796) (typesetting of the Index and explanations in the Preface) to be sufficient to dispel doubts about Hoffmann's acceptance of such taxa.

Hoffmann (1796) was the first to provide a description for Ehrhart's lichen under the name *Umbilicaria "spadochroa"*; although this species name was left unnumbered in the synopsis, it was listed as accepted in the Index and therefore was validly published in spite of any doubts that Hoffmann may have had at that time.

The species description provided by Hoffmann inadequately distinguishes between the *Umbilicaria* species in their current circumscription. Hoffmann distinguished *U. spodochroa* from its presumed closest relative *U. hirsuta* mostly by the colour of the upper thallus surface (bluish grey vs. grey) and the lower thallus surface (light brown vs. brownish grey), and also by rhizinomorph density (scarce vs. abundant). These characters are variable in both species in that the colour of the lower thallus surface varies from beige to black-brown and the rhizinomorphs are scarce to abundant. According to the current species concept, Hoffmann's description fits both taxa, *U. spodochroa* and *U. hirsuta*, so that it can be applicable either to a species different from *U. hirsuta* or it may indicate a phenotypic variation within the same species.

Further treatments

A later author who treated this lichen species was Acharius (1799), who validly published the combination *Lichen spodochrous* (as "spadochrous"), which he explicitly accepted and accompanied by a species description.

Acharius broadened the limits of this taxon and, disregarding priority, included one previously described species, *Umbilicaria cirrosa* Hoffm.; this name has not yet been typified but the figures accompanying the description by Hoffmann (1789) suggest that it may be a synonym of *U. vellea*.

Acharius (1799, 1803) specified the character of the lower surface of the thallus as dark hirsute ("subtus ater hirsutus"). Later, Acharius (1810: 673) emphasized that his *Gyrophora vellea* (L.) Ach., *G. spodochroa*, and *G. crustulosa* Ach. can be optimally distinguished by their apothecial morphologies. In this work, Acharius was the first to mention one of the most important diagnostic characters of *Umbilicaria spodochroa*, i.e., the prominent central button on the apothecia. Finally Acharius (1814) lowered the rank of the taxon to the varietal level but maintained its diagnostic characters.

It is rather obvious that the works of Acharius were essential in establishing the current concept of *U. spodochroa*. Nevertheless, despite the characters indicated in his descriptions, the specimens labelled by Acharius as "*Gyrophora vellea* β *G. spadochroa*" belong to *U. vellea* (H-ACH 581) or *U. vellea* and *U. cinereorufescens* (Schaer.) Frey (H-ACH 580). The specimens referable to *U. spodochroa* were identified by Acharius as "*Gyrophora vellea*" (H-ACH 576), in accordance with the illustration of the latter species in Acharius (1794: Tab. III, fig. 3).

Stenhammar (1825) described the same type of apothecia, with thick margin and a central verruca, for *Umbilicaria vellea* var. *spodochroa,* although the respective herbarium specimen was referred to *U. vellea* (Merrill 1906). The other important diagnostic characters of the species were unknown at that time.

Nylander (1861) established an additional character that can diagnose *Umbilicaria spodochroa:* ascospores that are simple and colourless to submuriform and brown. However, he treated *U. spodochroa* broadly and included other *Umbilicaria* taxa with submuriform ascospores: *U. cinereorufescens, U. cirrosa, U. crustulosa,* and *U. depressa* (Ach.) Duby (Nylander 1869).

This broad concept of *Umbilicaria spodochroa* prevailed until Frey (1933) recognized the four aforementioned species as separate and provided an artificial key and detailed descriptions, which are still accepted. Frey's treatment became the basis for all subsequent interpretations of *U. spodochroa* and established the current application of its name.

Type designation

Hoffmann (1796) cited two collections in the protologue, which are therefore syntypes. The first collection is *Lichen "spadochrous"* of Ehrhart (1793), which was erroneously cited under no. 317 instead of no. 316. The distribution of Ehrhart's exsiccatae was so limited (Gubanov & Balandina 2000) that this incorrect citation was reproduced in the great majority of subsequent taxonomic publications.

We were able to locate three specimens of Ehrhart's "*Lichen spadochrous*" at GOET, LINN-HS, and MW. In addition we checked B, BM, G, HAL, LE, M, and UPS (the herbaria in which some Ehrhart's collections are known to be located), but without success.

The specimen at GOET (barcode 019934) was studied by Arnold (1880) and Schade (1955), who referred it to *Umbilicaria hirsuta*. We agree with this identification because of its prominent marginal farinose-granular parasoredia.

The specimen at LINN-HS (1703.19.3) belongs to the Herbarium of Sir James Edward Smith, to which it went through the collection of Edmund Davall in 1802 (Beer 1947). According to the annotations, Smith referred it to "*Lichen polyrrhizos,*" although its correct identity is *Umbilicaria hirsuta*.

The specimen at MW belongs to the personal collection of F. Ehrhart, which was owned by Hoffmann who left its part, including sets of the exsiccatae, to the Moscow Branch of the Military Medical-Surgical Academy, from which the collections were transferred to the Moscow University after the Academy was closed in 1842 (Sokoloff & al. 2002). Some specimens of Ehrhart's cryptogams were purchased by the Botanical Museum of the St. Petersburg Academy of Sciences (now the Komarov Botanical Institute) (Karavaev & Barsukova 1968) but the specimen of *Lichen "spadochrous"* was left in Moscow (Gubanov & Balandina 2000). This specimen was certainly examined by Hoffmann and apparently was the main basis for the original description and his concept of *Umbilicaria spodochroa*. The traits of his specimen do match the original description well, but it evidently also belongs to *U. hirsuta*.

The second collection mentioned by Hoffmann (1796) is a specimen of "*Lichen polyrrhizos,*" which was communicated by Smith. We cannot recognise this specimen among the lichen collections of Hoffmann, which were purchased from him by Moscow University (Hoffmann 1825). However, a suitable specimen in Smith's herbarium (LINN-HS 1273.212), identified as "*Lichen polyrrhizos*" and originating from Ehrhart's collection, matches the

protologue of *Umbilicaria spodochroa*. This specimen, which was received by Smith most likely in 1793 (as evident from annotations on other similar specimens in this collection, e.g. LINN-HS 39.34) and may have been shared with Hoffmann prior to 1796, could be part of the gathering mentioned by Hoffmann in the protologue. This specimen also belongs to *U. hirsuta*.

The original description of *Umbilicaria spodochroa* and the relevant herbarium material convincingly demonstrate that this name was applied by Hoffmann to a variant of *U. hirsuta*, not to the species known as *U. spodochroa* in the current use. Arnold (1880) studied Ehrhart's lichen collections and stated that Ehrhart's specimen of *Lichen* "*spadochrous*" was mixed and the typical *U. spodochroa* was also present under no. 316; however, we have found no evidence for this statement. Moreover, *U. hirsuta* is common in the vicinity of Uppsala (Shah & Coulson 2018), the type locality of *U. spodochroa*, whereas *U. spodochroa* in its current concept is absent from Uppsala proper, although it occurs fairly close to the town, mostly along the coast and to some extent along the shores of Lake Mälaren (S. Ekman, pers. comm.).

Llano (1950: 101) rather mechanically cited "Ehrhart ... Crypt. Exs. 317" as the type of *Umbilicaria spodochroa*, thus fulfilling conditions for effective type designation [ICN (Shenzhen Code) Art. 7.11, 9.17]. This typification is formally correct but has an undesirable effect that a familiar species name would change its application because the type collection belongs to *U. hirsuta* although the species name has been widely and persistently used in the sense of *U. spodochroa* since Frey (1933). Llano's type designation is referable to a gathering rather than a specimen, since he failed to specify the herbarium in which the type is housed, but we refrain from the second-step typification of the name as unnecessary in view of a conservation proposal currently under review (Hestmark, submitted).

Umbilicaria spodochroa Hoffm., Deutschl. Fl. 2: 113. 1796, [as "*spadochroa*"]

≡ *Lichen spodochrous* (Hoffm.) Ach., Lichenogr. Suec. Prodr.: 149. 1799 ["1798"; as "*spadochrous*"]

≡ *Gyrophora spodochroa* (Hoffm.) Ach., Methodus: 108. 1803 [as "*spadochroa*"]

≡ *Gyrophora vellea* var. *spodochroa* (Hoffm.) Ach., Syn. Meth. Lich.: 68. 1814 [as "*spadochroa*"]

≡ *Umbilicaria vellea* var. *spodochroa* (Hoffm.) Stenh., Sched. Crit. Lichen. Suec. 5–6: 4. 1825 [as "*spadochroa*"]

≡ *Omphalodiscus spodochrous* (Hoffm.) Schol., Nyt Mag. Naturvid. 75: 26. 1934

Lectotype (designated by Llano 1950: 101)—Sweden. Uppsala, F. Ehrhart in Plantae Cryptogamae Linn. no. 316 (GOET [image!], LINN-HS [image!], MW [image!]).

Subgeneric nomenclature

Gyrophora Ach. was published as an explicit substitute [replacement name, ICN (Shenzhen Code) Art. 6.11] for the illegitimate *Umbilicaria* Hoffm. 1789 (non Fabr. 1759), even though the illegitimacy of Hoffmann's genus was not realized at that time (e.g., Leighton 1856). Acharius (1803: 100) cited Hoffmann's name in synonymy and stated that he changed the latter because he considered it "not optimal", thus making both names homotypic [ICN (Shenzhen Code) Art. 7.4]. Since the generic name *Umbilicaria* Hoffm. was illegitimate prior to its conservation in 1996 [ICN (Shenzhen Code) Art. 14.15], the autonym "*Umbilicaria* subg. *Umbilicaria*" cannot be established [ICN (Shenzhen Code) Art. 22.5]; because of the illegitimacy of the generic name, ICN (Shenzhen Code) Art. 22.2 does not apply and the combination *Umbilicaria* subg. *Gyrophora* (Ach.) Frey was validly published for a subdivision of the genus that includes the type of the generic name. When Davydov & al. (2017) accepted *U.* subg. *Gyrophora* but excluded from its circumscription the type of *Umbilicaria* (which is also the type of *U.* subg. *Gyrophora* (Ach.) Frey), also providing a description of this subgenus and a type designation, they created an illegitimate later homonym [ICN (Shenzhen Code) Art. 48.1] which, however, was not validly published under ICN (Shenzhen Code) Art. F.5.1. This subgenus is formally named here with the same type and a reference to the validating description in Davydov & al. (2017).

Two other subgeneric names accepted by Davydov & al. (2017) are revised with their corrected nomenclature as follows.

Umbilicaria* subg. *Agyrophora Nyl. [Flora 61: 247. 1878, nom. nud.] ex Cromb., Monogr. Lich. Britain 1: 323. 1894

Type (designated by Llano 1950: 49)—*Umbilicaria atropruinosa* Schaer. [= *Umbilicaria leiocarpa* DC.]

Umbilicaria* subg. *Lasallia (Mérat) Frey, Hedwigia 71: 106. 1931

≡ *Lasallia* Mérat, Nouv. Fl. Env. Paris, ed. 2, 1: 202. 1821

Type—*Umbilicaria pustulata* (L.) Hoffm.

Umbilicaria* subg. *Papillophora Davydov, Ahti & Sennikov, subg. nov. MB 830067

≡ "*Umbilicaria* subg. *Gyrophora*" sensu Davydov & al., Taxon 66: 1297. 2017.

Type—*Umbilicaria vellea* (L.) Ach.

Description—see Taxon 66: 1297. 2017, under *Umbilicaria* subg. *Gyrophora* "(Ach.) Frey".

Etymology—The name refers to the papillose lower surface and rhizinomorphs, the characteristic trait for the majority of species in the subgenus.

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Ochroconis terricola sp. nov. from China

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Abstract—A new species, *Ochroconis terricola*, was isolated from soil in Guizhou Province, China. Morphology and phylogenetic analyses of the combined sequence data of nuclear ribosomal DNA genes (ITS, LSU, SSU) revealed the strain as different from other *Ochroconis* species.

Key words—*Dothideomycetes,* hyphomycetes, *Sympoventuriaceae,* taxonomy, *Venturiales*

Introduction

Ochroconis, typified by *O. constricta* (E.V. Abbott) de Hoog & Arx, was morphologically separated from *Scolecobasidium* E.V. Abbott (Abbott 1927) by de Hoog & von Arx (1974), for species with unbranched, ellipsoidal to cylindrical conidia, while *Scolecobasidium* was retained for species having T- or Y-shaped conidia. However, the taxonomic status of *Scolecobasidium* was questioned due to ambiguity of its type species, *S. terreum* E.V. Abbott, and species with lobed conidia similar to *S. terreum* in *Scolecobasidium* have been combined in *Ochroconis* on phylogenetic grounds (Samerpitak & al. 2014). Historically, *Ochroconis* was characterized by sympodial conidiogenesis and septate, mostly rough-walled conidia that are liberated rhexolytically (Samerpitak & al. 2015, Ellis 1971). A recent multigene (nSSU, nLSU, mtSSU, RPB2) phylogenetic analysis places *Ochroconis* in *Sympoventuriaceae* (*Venturiales*, *Dothideomycetes*) (Machouart & al. 2014). By combining molecular phylogeny, morphology, and ecology, Samerpitak & al. (2014) revised the taxonomy of the *Ochroconis* lineage, introducing

Verruconis Samerp. & al. as a new genus for a group of thermophilic species around *O. gallopava* (W.B. Cooke) de Hoog [≡ *Verruconis gallopava* (W.B. Cooke) Samerp. & de Hoog]. (*Ochroconis* species are mesophilic.) ITS and LSU nuclear ribosomal sequences as well as the conserved SSU gene are all suitable for identifying species in *Ochroconis* and *Verruconis*, but the ITS and LSU regions are recommended as the best DNA barcoding candidates, due to the high variability found even in conserved markers (Samerpitak & al. 2014, 2015). Presently, 31 species are accepted in *Ochroconis* (http://www.mycobank.org).

During our 2018 investigation of dematiaceous hyphomycete diversity, we isolated one *Ochroconis*-like strain from soil in Guizhou Province, China. Now we propose a novel species, *Ochroconis terricola,* based on morphological characters and phylogenetic analyses of ITS, LSU, and SSU nuclear ribosomal sequences.

Materials & methods

Fungal isolates and morphological studies

Soil samples were collected from Guizhou Province, China, in 2018 and transported to the laboratory in sterilized, zip lock polyethylene bags. All isolates are conserved in the Herbarium of Department of Plant Pathology, Guizhou University (HGUP). The taxon is described from cultures grown for 2 weeks at 25°C on potato dextrose agar (PDA). Conidia and conidiophores were placed in a drop of 60% lactic acid, examined, and photographed at 100× magnification using a Nikon 90i microscope.

DNA extraction, amplification, sequencing

Genomic DNA was extracted from colonies grown on PDA using the Fungal gDNA Kit GD2416 following the manufacturer's instructions. ITS, LSU and SSU genes were amplified via PCR using primers ITS4/ITS5 (White & al. 1990), LROR/LR5 (Rehner & Samuels 1994, Vilgalys & Hester 1990), and NS1/NS4 (White & al. 1990), respectively. The PCR products were purified and sequenced by Sangon Biotech. The new sequences were deposited in GenBank, and other sequences were obtained from GenBank (Table 1).

Phylogenetic analyses

Sequences were aligned using ClustalX 1.81 (Thompson & al. 1997) and edited manually using BioEdit (Hall 1999). The alignments were concatenated as a Fasta document using MEGA 6.0 (Tamura & al. 2011). Phylogenetic analyses of combined ITS, LSU, and SSU rDNA sequences were computed using maximum likelihood (ML) analysis and Bayesian Inference (BI). The ML tree was generated using RAxML-HPC2 on XSEDE v.8.2.8 (Stamatakis 2014) via the CIPRES Science Gateway platform (Miller & al. 2010) with 1000 bootstrap replicates. Bayesian analysis was performed via MrBayes v3.0b4 (Huelsenbeck & Ronquist 2001) using Markov Chain Monte

Table 1. Sequences used in phylogenetic analyses.

Species	Strain	GenBank accession no.		
		ITS	SSU	LSU
Mycosisymbrium cirrhosum	GUFCC 18012	KR259883	KR259885	KR259884
Ochroconis bacilliformis	CBS 100442	KP798632	KP798638	KP798635
O. constricta	CBS 202.27(T)	MH854929	KF156072	KF282652
	CBS 211.53	HQ667519	KF282671	KF282653
	NH 1234	—	—	LC187202
	FMR 3906	LM644509	—	LM644552
	NBRC 9375	DQ307327	AB564608	AB564619
O. cordanae	CBS 475.80(T)	KF156022	KF282672	KF282654
O. gamsii	CBS 239.78(T)	KF156019	KF156088	KF156150
O. icarus	CBS 536.69(T)	HQ667524	KF156084	KF156132
O. macrozamiae	CBS 101179	KF156020	KF156091	KF156151
	CBS 102491	KF156021	KF156092	KF156152
O. minima	CBS 423.64	—	KF282680	KF282666
	CBS 119792	KF156027	KF156086	KF156133
	CBS 510.71(T)	HQ667522	KF156087	KF156134
O. phaeophora	CBS 206.96	KP798631	KF282675	KF282660
O. ramosa	UTHSC 121082(T)	LM644524	LM644551	LM644567
O. robusta	CBS 112.97(T)	KP798633	KP798639	KP798636
O. sexualis	PPRI 12991(T)	KF156018	KF156089	KF156118
O. terricola	**HGUP1808(T)**	**MK377301**	**MK377071**	**MK377073**
Pleospora herbarum	CBS 191.86	KC584239	GU238232	GU238160
Scolecobasidium cateniphorum	CBS 769.83	KF156013	KF156044	KF156153
S. excentricum	CBS 469.95(T)	HQ667543	KF156096	KF156105
S. fusarioideum	CBS 210.95	—	KF156043	KF156154
S. fusiforme	CBS 586.82	KF156012	KF156101	KF156155
Scolecobasidium sp.	NH503	—	AB564606	AB564617
S. terreum	PO43	—	EU107356	EU107306
S. tricladiatum	PO51	—	EU107354	EU107286
S. tropicum	CBS 380.87	—	KF156042	KF156102
Venturia asperata	ATCC 34052	—	EF114736	EF114711
V. inaequalis	CBS 594.70	KF156040	GU296205	GU301879
V. populina	CBS 256.38	MH855959	GU296206	GU323212
V. pyrina	ATCC 38995	—	EF114739	EF114714
Veronaeopsis simplex	CBS 588.66(T)	KF156041	KF156095	KF156103
Verruconis calidifluminalis	CBS 125818(T)	MH875239	KF156046	KF156108
V. gallopava	CBS 437.64(T)	HQ667553	KF282674	KF282656
V. verruculosa	CBS 119775	KF156014	KF156055	KF156106

New sequence is set in **bold** font. Type strains are marked by T.

Carlo method. *Pleospora herbarum* (CBS 191.86) was used as an outgroup. The phylogenetic tree was viewed in Treeview v. 1.6.6 and the layout was completed in Adobe Illustrator CS5.

Taxonomy

Ochroconis terricola Xin Zhang & Y.L. Jiang, **sp. nov.** Fig. 1

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Differs from *Ochroconis macrozamiae* by its dark brown conidiophores and subhyaline to pale brown conidia, from *O. gamsii* by its flexuous conidiophores and bigger conidia, and from *O. sexualis* by its 1-septate and much smaller conidia.

Type: China, Guizhou Province, Leishan County, from forest soil, March 2018, X. Zhang (**Holotype**, HGUP1808; ex-type culture, HGUP1808; GenBank MK377301, MK377071, MK377073).

Etymology: referring to living on the soil.

Colonies on PDA effuse, flat, velvety, olivaceous, reverse dark brown, growing slowly, attaining 9 cm diam. at 25° after 4 weeks. Mycelium immersed and superficial, hyphae hyaline to pale brown, smooth. Conidiophores unbranched, 1–6 septa, flexuous, thick-walled, dark brown, 2–4 µm diam., with sympodially proliferating conidiogenous cells bearing one or more denticles in the apical region. Conidiogenous cells terminal, integrated, 1–3 µm long, polyblastic, cylindrical, subhyaline to medium brown. Conidia rhexolytic secession from conidiophores, solitary, subhyaline to pale brown, coarsely verrucose, 1-septate, sometimes slightly constricted at the septum, ellipsoidal to cylindrical or fusiform, apex mostly rounded, base narrowly truncated with minute marginal frills, 7–12 × 2–4 µm.

Phylogenetic analysis

The final alignment contained three genes for 36 isolates and 2568 (765 ITS + 827 LSU + 976 SSU) characters with *Pleospora herbarum* (CBS 191.86) as outgroup. The ML phylogenetic tree is shown (Fig. 2). Empirical base frequencies with 1,000 bootstrap inferences are 0.249211 (pi A), 0.221282 (pi C), 0.295026 (pi G), and 0.234480 (pi T). Bayesian analysis generated a similar phylogenetic tree (one million generations; average standard deviation of split frequencies = 0.009724). The *Ochroconis terricola* (HGUP 1808) sequences cluster together in a clade with *O. macrozamiae* Crous & R.G. Shivas, *O. gamsii* de Hoog, and *O. sexualis* Samerp. & al. (Fig. 2) and form a single branch sister to the other three species with high bootstrap support (ML/BI = 84/1).

Discussion

In this study, one *Ochroconis* strain (HGUP1808) isolated from soil was identified based on morphological characters and molecular data.

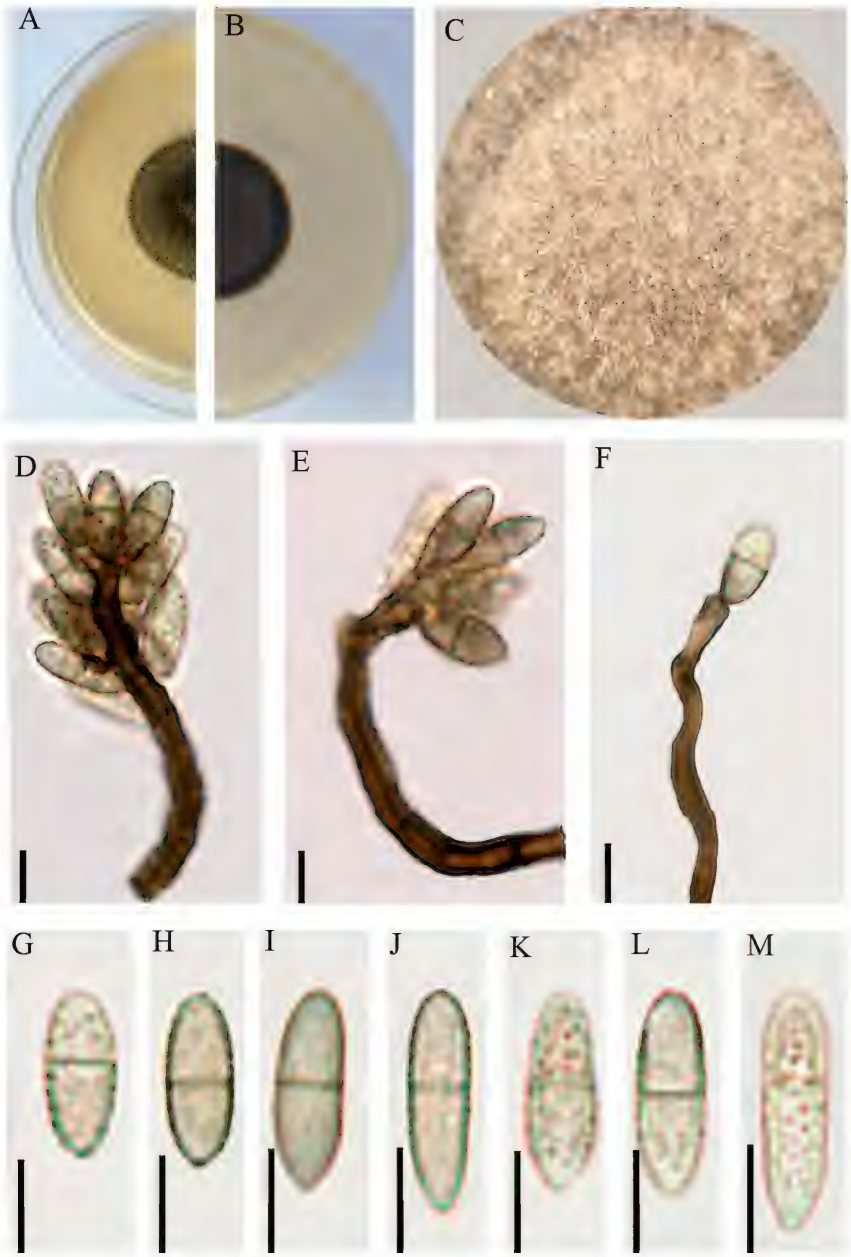

Fig. 1. *Ochroconis terricola* (holotype, HGUP1808). A, B: Colony on PDA at 14 days; C: Mycelia on the colony; D–F: Conidiophores and conidia; G–M: Conidia. Scale bars = 5 μm.

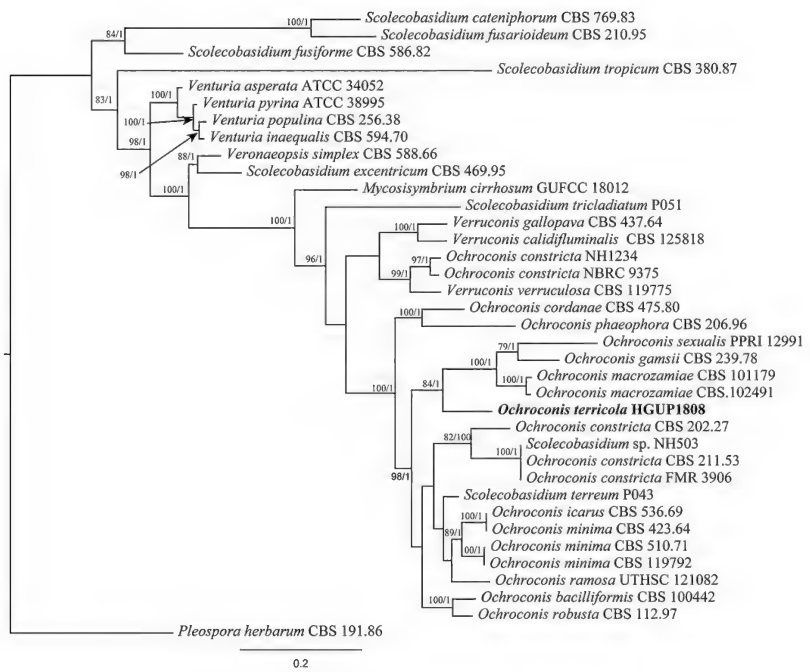

FIG. 2. Maximum Likelihood (ML) tree based on combined LSU, ITS, and SSU data of *Ochroconis* species and other related genera species, with *Pleospora herbarum* (CBS 191.86) as outgroup. Branch support is shown as: Maximum Likelihood bootstrap support values >75% / Bayesian posterior probabilities >0.95. The new species is in bold.

SSU, ITS, and LSU multi-gene analyses support phylogenetic separation of *O. terricola* from known *Ochroconis* species within a single clade in the ML tree. Although *Ochroconis terricola* is phylogenetically close to *O. macrozamiae, O. gamsii*, and *O. sexualis* in the phylogram (FIG. 2), there are obvious morphological differences separating *O. terricola* and the three species. *Ochroconis macrozamiae* is distinguished by its red-brown conidiophores and conidia that constrict at the middle septum (Crous & al. 2014); *O. gamsii* differs by its erect conidiophores and curved or unilaterally flattened, smaller conidia (6-9 × 2.4-2.8 µm; de Hoog 1985); and *O. sexualis* differs by its 1-3-septate, larger conidia (15-22 × 3.5-5.0 µm; Samerpitak & al. 2014). The combined morphological and phylogenetic analysis supports *O. terricola* as a new taxon.

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Neomyrmecridium asymmetricum sp. nov. from Ecuador

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Abstract—A new species *Neomyrmecridium asymmetricum,* found on decaying leaves of *Theobroma cacao*, is distinguished by grouped conidiophores and polyblastic production of narrow clavate to subclavate, 1-septate, asymmetrical, and yellowish or subhyaline conidia. An ITS- and LSU-based phylogenetic analysis, description, and illustrations are provided. A key and illustrations to *Neomyrmecridium* species are also presented.

Key words—asexual fungi, *Myrmecridiaceae,* taxonomy, tropics

Introduction

Crous & al. (2018a) introduced *Neomyrmecridium* Crous for three species: *N. septatum* Crous (type species), *N. asiaticum* Crous, and *N. sorbicola* (Crous & R.K. Schumach.) Crous. *Neomyrmecridium* is distinguished by macronematous, unbranched, subcylindrical, multiseptate, smooth, brown

conidiophores with polyblastic, terminal, subcylindrical, denticulate, pale brown conidiogenous cells. The conidia are solitary, fusoid-ellipsoid, obovoid, hyaline or subhyaline (becoming pale brown with age), septate, smooth, and sometimes encased in mucoid tunica (Crous & al. 2018a). The diversity of microfungi in the Ecuadorian rainforests has received little attention, especially in cacao plantations. During a survey of hyphomycetes associated with plant litter in the Balao cacao plantation, Guayas province, Ecuador (Fig. 1), we collected a *Neomyrmecridium* specimen that differs remarkably from all previously described taxa (Crous & al. 2018a) and for which we propose a new species.

Materials & methods

Collections

Samples of decaying plant materials were collected and placed in plastic bags for transport to the laboratory, where they were washed, treated according to Castañeda-Ruiz & al. (2016), and placed in moist chambers. Pure cultures were obtained by transferring single conidium using a flamed needle to solidified media (with pH adjusted to 6.3) containing corn meal extract mixed 1:1 with carrot extract plus 15 g agar (CMC) or V8 according to Crous & al. (2009). Plates were incubated at 25 °C. Color notations in parentheses are from Kornerup & Wanscher (1984). Mounts were prepared in PVL (polyvinyl alcohol, lactic acid) and measurements made at 1000× magnification. Microphotographs were obtained with an Olympus BX51 microscope equipped with bright field and Nomarski interference optics. The type specimen was deposited in the Herbarium of Universidade Federal de Pernambuco, Recife, Brazil (URM) and cultures obtained from the type specimen were deposited in the Culture collections of Microorganism CIBE (CCM-CIBE), Guayaquil, Ecuador.

DNA extraction, sequencing, and phylogenetic analysis

Isolates CCMCIBE-H304 and CCMCIBE-H304-A were cultured on PDA in darkness for 7 days at 25 °C. DNA was extracted using a modified protocol from Cenis (1992). The primers ITS1/ITS4 were used to amplify ITS regions, including the 5.8S gene (Manter & Vivanco 2007), and LROR/LR5 to amplify the D1/D3 domain of the LSU nrDNA (White & al. 1990). PCR products were sent to Macrogen Inc. (South Korea) for purification and sequencing. Consensus sequences assembled and edited using Geneious (ver. 10.1.2) were later compared with those of the National Center for Biotechnology Information (NCBI) using the Basic Local Alignment Search Tool (BLAST).

Each data set was aligned in MEGA 6.0 (Tamura & al. 2013) using ClustalW (Thompson & al. 1994) and refined with MUSCLE (Edgar 2004). The alignment included our strain sequences and those from different genera in the *Myrmecridiaceae* obtained from NCBI (Table 1). ITS- and LSU-based

FIG. 1. Balao cacao plantation, Guayas province, Ecuador.

Table 1. Sequences of *Neomyrmecridium* and allied taxa used for phylogenetic analyses.

Species	Strain	ITS	LSU	Reference
Neomyrmecridium asiaticum	CBS 145080	MK047444.1	MK047494.1	Crous & al. (2018a)
N. asymmetricum	CCMCIBE-H304	MN014057	MN014055	**This study**
	CCMCIBE-H304-A	MN014058	MN014056	**This study**
N. septatum	CBS145073	MK047442.1	MK047492.1	Crous & al. (2018a)
N. sorbicola	CBS:143433	MH107901.1	MH107948.1	Crous & al. (2018b)
Beltraniella endiandrae	CBS 137976	KJ869128	NG_058665.1	Crous & al. (2014)
B. humicola	CBS 203.64	MH858416.1	MH870044.1	Vu & al. (2019
B. portoricensis	NFCCI 3993	KX519516	KX519522.1	Rajeshkumar & al. (2016)
	CBS 856.70	MH859981.1	MH871777.1	Vu & al. (2019)
Cancellidium applanatum	CBS 137655	—	KF833359.1	Zelski & al. (2014)
	CBS 337.76	NR_159777.1	MH872755.1	Vu & al. (2019)
Castanediella acaciae	CPC 24869	KR476728.1	KR476763.1	Crous & al. (2015a)
Cas. cagnizarii	CBS 101043	KP859051.1	KP858988.1	Hernández-Restrepo & al. (2016a)
	CBS 579.71	MH860269.1	MH872031.1	Vu & al. (2019)
Cas. eucalypti	CBS 139897	—	MH878665.1	Vu & al. (2019)
	CBS 139897	NR_137981.1	KR476723.1	Crous & al. (2015a)
Cas. malaysiana	CPC 24918	NR_154810.1	KX306781.1	Hernández-Restrepo & al. (2016b)
Cas. tereticornis	CBS:145068	MK047417.1	MK047468.1	Crous & al. (2018a)
Lasiosphaeria sorbina	GJS L555	AY587934.1	AY436415.1	Miller & Huhndorf. (2004)
Myrmecridium banksiae	CBS 132536	NR_111762.1	NG_042684.1	Crous & al. (2012)
M. flexuosum	CBS 398.76	EU041768.1	EU041825.1	Arzanlou & al. (2007)
M. fluviae	CNUFC-YR61-2	KX839679.1	KX839676.1	Tibpromma & al. (2017)
M. montsegurinum	PRM 934684	KT991674.1	KT991664.1	Réblová & al. (2016)
M. phragmitis	CBS 131311	NR_137782.1	NG_057948.1	Crous & al. (2011)
M. schulzeri	CBS 100.54	EU041769.1	EU041826.1	Arzanlou & al. (2007)
M. spartii	CPC 24953	KR611884.1	KR611902.1	Crous & al. (2015b)

Neopyricularia commelinicola	CBS 128303	—	KM009151.1	Crous & al. (2016a)
	CBS 128303	KM484868.1	KM484982	Klaubauf & al. (2014)
Pararamichloridium caricicola	CBS:145069	MK047438.1	MK047488.1	Crous & al. (2018a)
P. livistonae	CBS 143166	NR_156652.1	NG_058504.1	Crous & al. (2017a)
P. verrucosum	CBS 128.86	MG386030.1	NG_057768.1	Crous & al. (2017a)
Porobeltraniella porosa	NFCCI 3996	KX519520.1	KX519526.1	Rajeshkumar & al. (2016)
Pseudopyricularia bothriochloae	CPC 21650	NR_137838.1	NG_058051.1	Crous & al. (2013)
Ps. hagahagae	CPC 25635	KT950851.1	NG_059616.1	Crous & al. (2015c)
Ps. hyrcaniana	Ck3	NR_158928.1	KY457267.1	Pordel & al. (2017)
Ps. iraniana	IRAN 2761C	NR_158928.1	NG_060183.1	Pordel & al. (2017)
Pyricularia urashimae	CPC 29414	NR_154361.1	NG_059752.1	Crous & al. (2016b)
Pyriculariomyces asari	CPC 27444	—	MH878225.1	Vu & al. (2019)
	CPC 27444	KX228291.1	KX228342	Crous & al. (2013)
Saccharata proteae	CBS:119218	EU552145.1	EU552145.1	Crous & al. (2017b)
Thozetella fabacearum	MFLU 16-1021	KY212754.1	NG_059767.1	Perera & al. (2016)
T. nivea	MUCL 41041	EU825201.1	EU825200.1	Jeewon & al. (2009)
T. pinicola	RJ-2008	EU825197.1	EU825195.1	Jeewon & al. (2009)
T. tocklaiensis	CBS 378.58	MH857817.1	MH869349.1	Vu & al. (2019)
Vermiculariopsiella acaciae	CPC 26291	KX228263.1	KX228314.1	Crous & al. (2013)
V. dichapetali	CBS:143440	MH107924.1	MH107970.1	Crous & al. (2018b)
V. eucalypti	CPC 25525	KX228251.1	KX228303.1	Crous & al. (2013)
V. eucalypticola	CBS:143442	MG386070.1	MG386123.1	Crous & al. (2017a)
V. immersa	MUCL39135	KJ476965	KJ476961.1	Becerra-Hernández & al. (2016)
V. lauracearum	CBS:145055	MK047436.1	MK047487.1	Crous & al. (2018a)
V. pediculata	CBS132484	MH866028.1	MH877476.1	Vu & al. (2019)
Woswasia atropurpurea	WC 18S	NR_154480.1	JX233658.1	Jaklitsch & al. (2013).
Xylochrysis lucida	CBS 135996	—	MH877601.1	Vu & al. (2019)
	CBS 135996	NR_132063.1	NG_058028.1	Réblová & al. (2014)

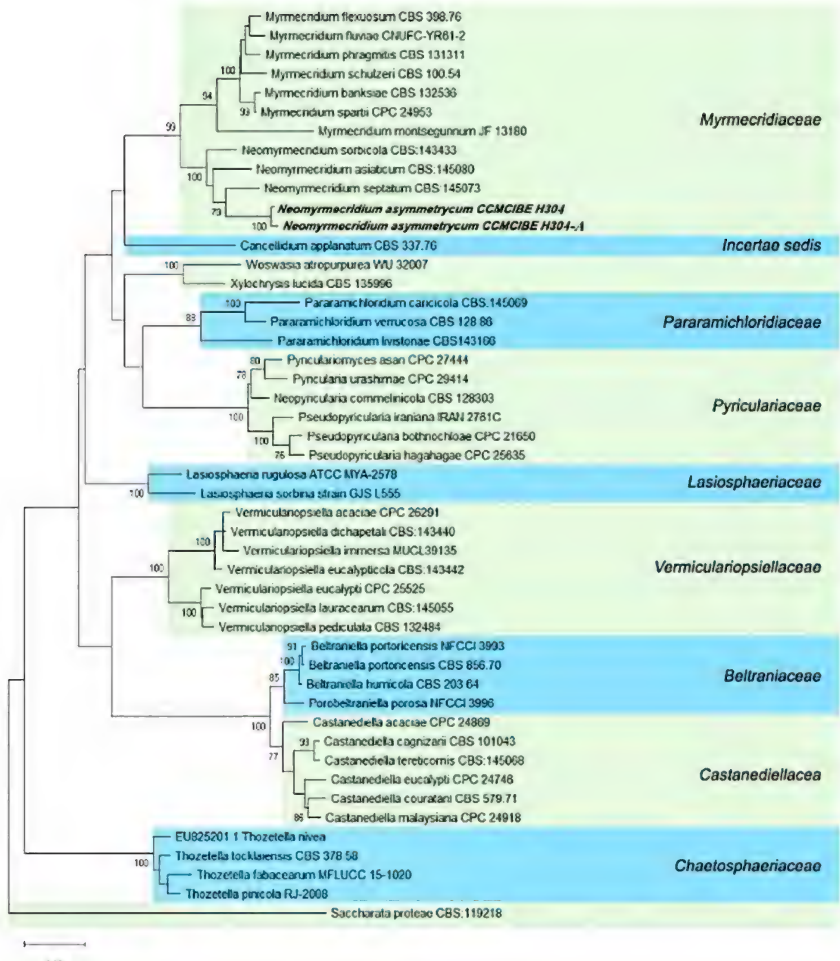

FIG. 2. The tree derived from the phylogenetic analysis using concatenated sequences of the LSU and ITS of *Myrmecridiales* revealed that *Neomyrmecridium asymmetricum* and *N. septatum* CBS:145073 were nested in a well-supported subclade (bootstrap value of 79).

phylogenies were generated using Maximum Likelihood (ML) with the best nucleotide substitution model in MEGA 6.0 (Tamura & al. 2013).

Best models used were (for LSU) Tamura-Nei with Gamma distribution and (for ITS) Kimura 2-parameter with Gamma distribution and Invariant sites (G+I). The best nucleotide substitution model for the combined LSU + ITS analysis was the General Time Reversible with Gamma distribution and Invariant sites (G+I). Bootstrap analysis of 1,000 replicates was used to assess the reliability

of the reconstructed phylogenies. ML bootstrap values ≥70% were considered significant. DNA sequences generated in this study were deposited in GenBank (Table 1).

Phylogeny

The BLAST query revealed that the CIBE H304 and CIBE H304-A LSU sequences of *N. asymmetricum* showed a 97% similarity with *N. septatum* CBS145073 and *N. asiaticum* CBS145080. However, they showed sequence identity of 94–96% with LSU sequences of *Myrmecridium* species, also belonging to the *Myrmecridiaceae*. The CIBE H304 and CIBE H304-A ITS sequences showed a 90 % similarity with *N. sorbicola* CBS143433, the highest value matched after blast search.

We carried out individual and combined analyses of the LSU and ITS loci to assess relationships with members of the *Myrmecridiales* (*Sordariomycetes*) (Fig. 2). The final concatenated analysis encompassed 48 sequences and comprised 1118 bp (ITS 555 bp, LSU 563 bp). The ML tree nested both *N. asymmetricum* isolates (CIBE H304 and CIBE H304-A) and *N. septatum* CBS145073 in a well-supported subclade (bs = 79%), with *N. asiaticum* CBS 145080 as the closest sister species (Fig. 2).

Taxonomy

Neomyrmecridium asymmetricum R.F. Castañeda, Serrano & D. Sosa, **sp. nov.** Figs 3–5

MycoBank MB 831330

Differs from *Neomyrmecridium sorbicola* by its narrow clavate to subclavate, 1-septate, asymmetrical conidia.

Type: Ecuador, Guayas Province, Guayaquil, Balao, 2°48 S 79°40 W, on decaying leaves of *Theobroma cacao* L. (*Malvaceae*), 8 July 2017, F. Espinoza & S. Pérez-Martínez (**Holotype,** URM 90896; ex-type cultures, CCMCIBE-H304, GenBank MN014057, MN014055; and CCMCIBE-H304-A, GenBank MN014058, MN014056).

Etymology: *asymmetricum-* (Latin), meaning asymmetric.

Colonies on the natural substrate hairy, effuse, amphigenous, yellowish brown. Mycelium superficial and immersed, composed of branched, 1–2.5 µm diam, smooth, brown hyphae. Conidiophores macronematous, mononematous, grouped, slightly fasciculate, erect, straight, cylindrical, unbranched, 3–15-septate, brown, pale brown toward the apex, 40–210 × 3.5–9 µm, smooth. Conidiogenous cells polyblastic, terminal, integrated, cylindrical or subcylindrical, indeterminate, with several sympodial extensions, denticulate, with tiny cylindrical denticles, pale brown, 8–35 ×

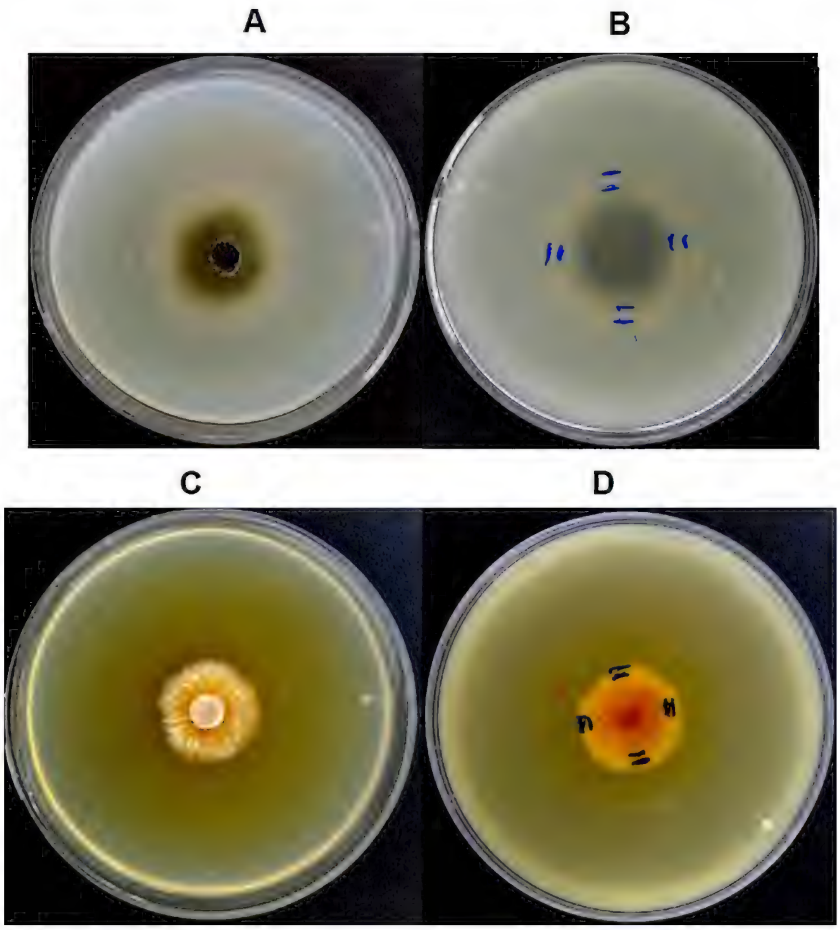

Fig. 3. *Neomyrmecridium asymmetricum* (cultures ex holotype, URM 90896). A–D. Colonies and reverses on CMC (A–B) and V8 agar (C–D).

3.5–5 µm. Conidial secession schizolytic. Conidia solitary, acropleurogenous, narrow clavate or subclavate, 1-euseptate, asymmetrical, 12–15 × 2–3 µm, basal cell 7–10 µm long, apical cell 4–6 µm long, yellowish or subhyaline, smooth-walled.

Culture characteristics: Colonies on CMC attaining 22 mm in 7 days at 25°C, flat, subfelted, olive (3/E5). Mycelium mostly immersed, scarcely aerial toward the entire margin. Reverse dark green (30/F6). Hyphae septate,

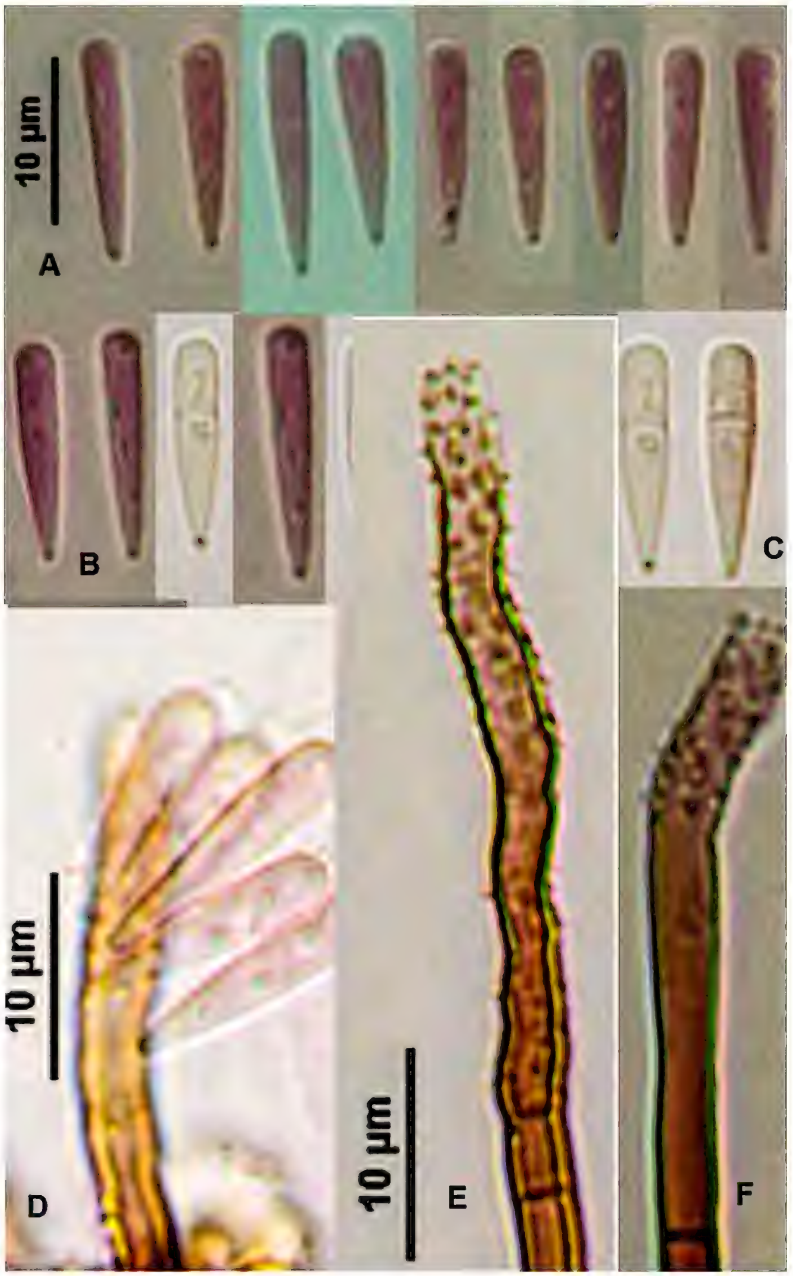

FIG. 4. *Neomyrmecridium asymmetricum* (holotype, URM 90896).
A–C. Conidiophores and conidiogenous cells. D. Conidiogenous cell.

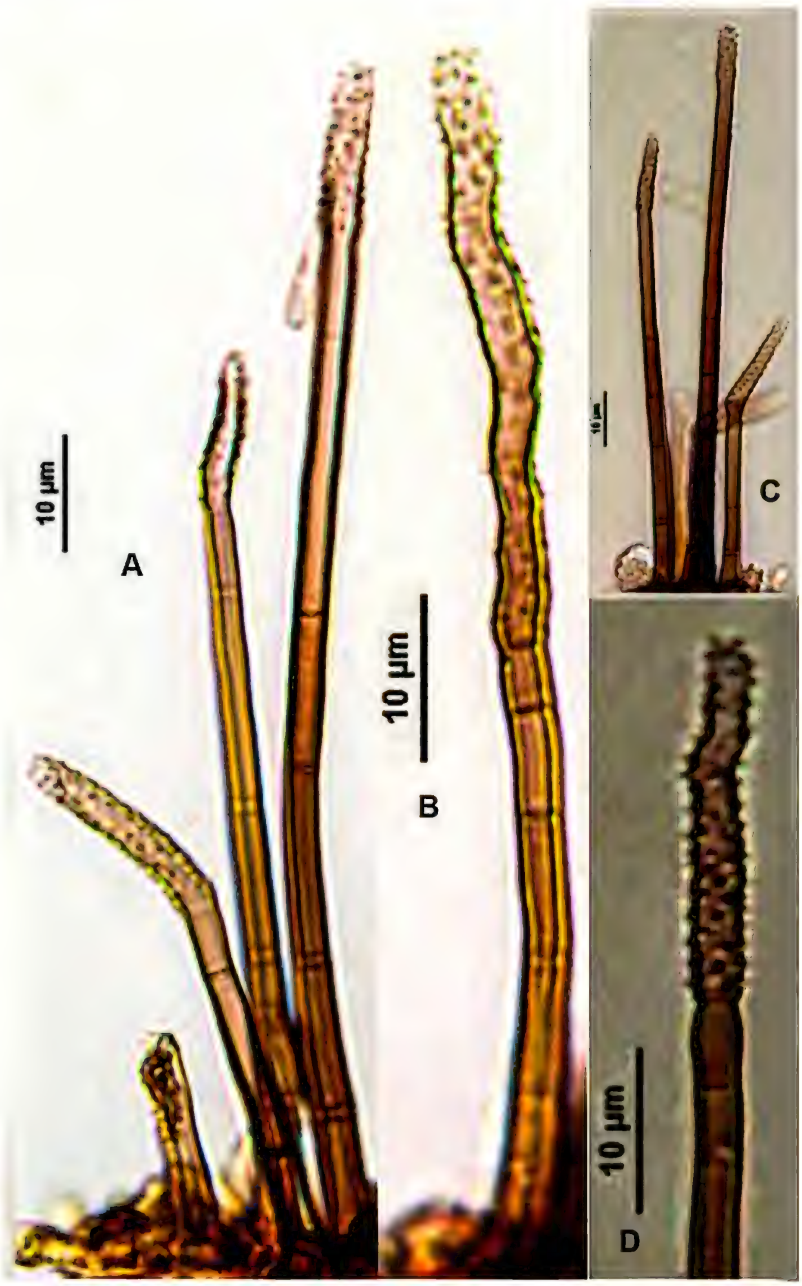

Fig. 5. *Neomyrmecridium asymmetricum* (holotype, URM 90896).
A–C. Conidia. D. Conidiogenous cell and conidia. E–F. Conidiogenous cells.

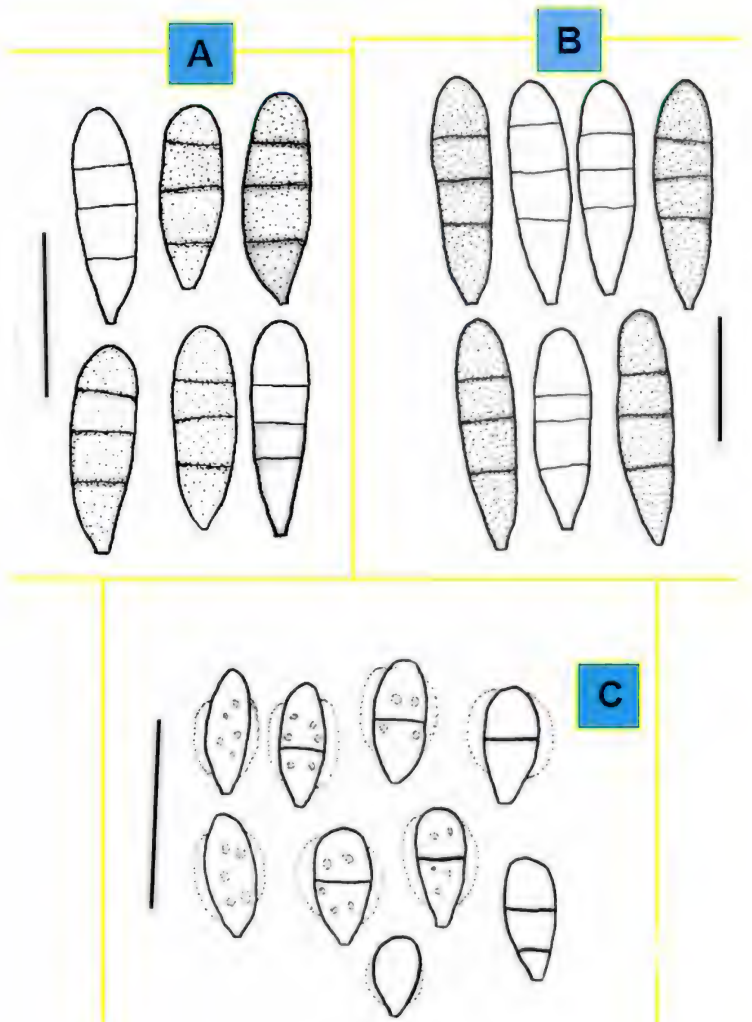

FIG. 6. Representative conidia of *Neomyrmecridium* spp. (re-drawn from the literature). A. *N. asiaticum* (Crous & al. 2018a). B. *N. septatum* (Crous & al. 2018a). C. *N. sorbicola* (Crous & al. 2018b). Scale bars = 10 µm.

subhyaline to pale olivaceous-brown, smooth, 1.5–2 µm diam. Sporulation occurred after 4 days, producing conidia similar to those observed from nature. Colonies on V8 agar attaining 12 mm in 7 days at 25°C, flat concentric near cottony center, filamentous-filiform toward margin, yellowish orange (4/A7).

Reverse deep orange (5/A8) at the center, light orange (5/A6) toward the margin. Sporulation poor and sparsely after 5 days, conidia similar to those observed from nature.

NOTE: *Neomyrmecridium sorbicola* (Crous & al. 2018a,b) is superficially similar to *N. asymmetricum* in producing 1-septate conidia, but *N. sorbicola* differs in its pale brown obovoid conidia with median regions surrounded by a mucoid tunica (FIG. 6). *Neomyrmecridium septatum* is separated by its conidia, which are fusoid-ellipsoid, mostly 3-septate, guttulate, pale brown, and with a mucoid tunica encasing the upper two thirds (Crous & al. 2018a) (FIG. 6).

Morphological and phylogenetic analyses support *N. asymmetricum* as a new species in *Myrmecridiaceae*.

Key to *Neomyrmecridium* species

1. Conidia mostly 1-septate 2
1. Conidia mostly more than 1-septate 3
2. Conidia clavate or subclavate, 12–15 × 2–3 µm, asymmetrical, basal cell 7–10 µm long, apical cell 4–6 µm long, yellowish or subhyaline ..... ***N. asymmetricum***
2. Conidia obovoid, (7–)8–10(–15) × 4(–5) µm, initially hyaline (pale brown in age), (0–)1(–3)-septate, with a 1–2 µm thick mucoid tunica surrounding the medial region ..... ***N. sorbicola***
3. Conidia fusoid-ellipsoid, (12–)14–16(–20) × (3.5–)4(–5) µm, hyaline (pale brown in age), (1–)3-septate, guttulate, with a 1–2 µm thick mucoid tunica encasing the upper two thirds ..... ***N. septatum***
3. Conidia ellipsoid to obovoid, (13–)15–17 × 4–5 µm, pale brown, (2–)3-septate, guttulate, surrounded by a 0.5 µm thick gelatinous tunica ..... ***N. asiaticum***

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A comparison of anamorphs of some *Pachyphlodes* species and the type of *Chromelosporium:* are they congeneric?

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Abstract—There is a question of whether or not the name *Chromelosporium* competes with the name *Pachyphlodes* given that both genera exhibit similar conidiogenesis. We address here the question through a comparative study of their anamorphs. The type specimen of *C. ochraceum* (generic type of *Chromelosporium*), has been studied and compared to newly collected specimens of two *Pachyphlodes* species, *P. nemoralis* and *P. citrina* (whose identity was confirmed through comparison of ITS DNA sequences) and an unidentified species from the *Pachyphlodes–Plicariella* lineage. Comparison of the morphology of the *Pachyphlodes–Plicariella* lineage anamorphs with *Chromelosporium ochraceum* reveals discriminating characters that may support a generic distinction.

Keywords—*Ascomycota, Glischroderma, Pezizaceae,* molecular analyses

Introduction

Corda (1833) described *Chromelosporium* in Sturm's Deutschlands Flora for a fungus collected in 1827 on dead stems of *Allium* (*Amaryllidaceae*) and *Hemerocallis* (*Xanthorrhoeaceae*) and characterized by ochre spores and hyphae immersed in a gel. Subsequent authors, however, overlooked the presence of the gelatinous matrix reported by Corda (1833). *Chromelosporium* has had a confusing history due to similarities of conidiogenesis found in *Hyphelia* Fr., *Ostracoderma* Fr., and *Glischroderma* Fuckel.

Juel (1920) noted that the conidiogenesis in collections of *Hyphelia terrestris* Fr. and in a fungus that he collected on soil in Môsseberg in western

Gotland, Sweden, considered to represent *Ostracoderma pulvinatum* Fr., were similar. Consequently, Juel reduced *Ostracoderma* to a synonym of *Hyphelia*. No original specimen of *Ostracoderma pulvinatum*, from Fries or Juel, were found in the S herbarium, impeding attempts to confirm whether the peridium described by Fries for *Ostracoderma* as "peridio rotundato minime villoso sed crustaceo" and the one supposedly observed by Juel (1920) are made of a definite pseudotissue of dense intricate hyphal cells enveloping the totality of the conidioma as in *Glischroderma cinctum* Fuckel or comprises just a superficial agglutination of hyphae embedded in a gel that upon drying becomes a crust-like thin layer, covering only parts of the hyphal mat—a "peridium indeterminatum e villo in pelliculam cohaerentem context," as observed by Fries in *Hyphelia* and by Korf (1994).

Because Fries based his generic type, *Hyphelia rosea*, on "*Trichoderma roseum* Pers. (non *Trichothecium* Link)," Hughes (1958) [having identified *Trichoderma roseum* Pers. and *Trichothecium roseum* (Pers.) Link as homotypic] considered the name *Hyphelia* no longer available. Therefore, Hughes (1958) rejected Juel's synonymy and, following Juel's observations, adopted *Ostracoderma* for species with similar conidiogenesis, such as *Hyphelia terrestris* and *Chromelosporium ochraceum*, making *Chromelosporium* a synonym of *Ostracoderma*. Hennebert (1973) segregated the non-peridiate *Chromelosporium* (with *C. ochraceum* and other species) from the peridiate *Ostracoderma* and *Glischroderma*.

Korf (1994) reported several *Chromelosporium*-like specimens from soil and litter in New York State with a superficial gelatinous mass, which he placed in *Glischroderma,* a genus described by Fuckel in 1870 and characterized by a superficial sticky gel (*glischros* = viscous). Norman and Egger (1999) sequenced one of Korf's anamorphs and demonstrated that it was affiliated with the *Pachyphlodes–Plicariella* [as *Scabropezia*] lineage. In examining Korf's specimens identified as *Glischroderma,* Healy (2015) recognized additional epigeous anamorphs of *Pachyphlodes* species and molecularly linked *Pachyphlodes pfisteri*, a truffle with a *Chromelosporium*-like anamorph. Hennebert (2017) subsequently distinguished *Chromelosporium* from *Glischroderma*[(1)].

[(1)] The list of specimens examined under *Pachyphlodes pfisteri* in Hennebert (2017) erroneously cites specimens received on loan from CUP instead of citing specimens identified as *Pachyphlodes pfisteri* (represented by CUP 62646, 62650, 62651, 62653, 63540, 63648) based on conidial size and ornamentation and hyphal width; CUP 62652, 62654, 63647, 63695 represent undefined species.

The presence of gel embedding the conidiogenous cells in *Chromelosporium* incited the senior author to search for fresh samples for further investigations. Fourteen samples of *Chromelosporium*-like spore mats were then collected on bare or mossy soils or mixed with organic debris in forests in Belgium, some of them bearing a few gel droplets. These *Chromelosporium*-like specimens were identified by ITS barcoding as two species of *Pachyphlodes* and an undetermined species of the *Pachyphlodes–Plicariella* lineage. Their anamorphs are described below and compared to the type specimen and original description of *Chromelosporium ochraceum*. This comparative morphological study revealed clear distinctions from *Chromelosporium ochraceum*.

Materials & methods

Specimens. Fourteen specimens were collected in the forest, accessioned, and deposited in MUCL. The type specimen of *Chromelosporium ochraceum* (A.C.J. Corda 155414) was borrowed from the Herbarium Kryptogamologicum Musei Nationalis Pragae in Prague (PRM). Microscopical examinations and drawings were carried out using a 1960 phase contrast Olympus FH microscope equipped with a Wild drawing tube. The photographs used in figure 6 were made with an Olympus BX50 microscope equipped with Olympus SC100 numerical camera and Olympus screen. All drawings and photographs are made from samples mounted in lactic acid with Cotton blue.

Sequencing. DNA was extracted from fragments of five freshly collected samples in lysis buffer, using innuPREP Plant DNA kit following the manufacturer's recommendations. Sequences were determined for the nuc rDNA ITS1-5.8S-ITS2 region (ITS) with the primer pair ITS5 and ITS4 (White & al. 1990). PCR conditions are as described in Gordillo & Decock (2018). Amplicons were sequenced in both directions by Macrogen Inc. (Korea) using the same primers. MK prefixes designate sequences deposited in GenBank.

Taxonomy

Anamorph of *Pachyphlodes nemoralis* Hobart, Bóna & A. Paz, Ascomycetes.org. 7(6):363, 2015 Figs 1, 6a

Hyphal mats forming cushion-shaped or flattened patches, irregular in outline, grouped, 3–23 mm in diam., 1–3 mm high, white when young discoloring to pale yellow ochre when mature, the surface appearing fluffy to compacted, with a few superficial, small droplets of translucent, glutinous, liquid gel, drying orange and flattened, small, brittle crust-like, the margin remaining fluffy and powdery.

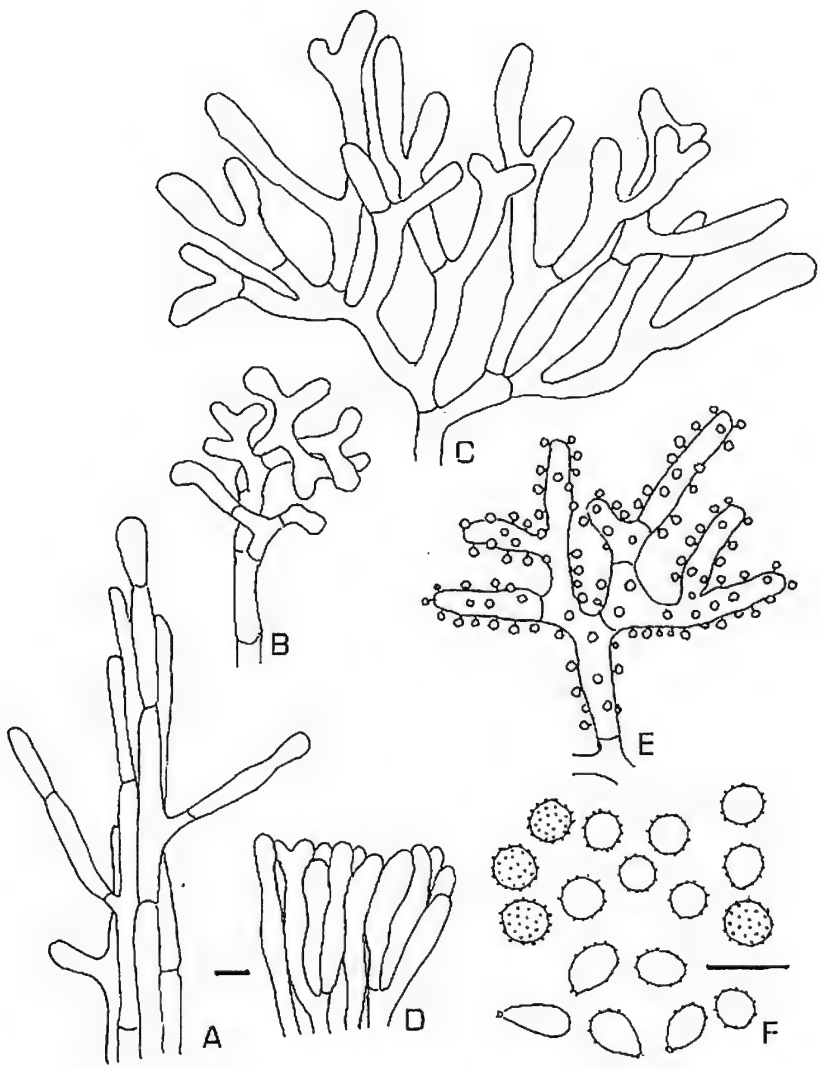

Fig. 1. *Pachyphlodes nemoralis* anamorph (MUCL 56524).
A. Synnema. B. Young branching. C. Open branching. D. Compact terminal cells.
E. Conidiogenous branches. F. Conidia (Scale bars = 10 µm).

Hyphae at first loosely interwoven, smooth, hyaline, 4–8 µm diam., becoming fasciculate, forming hyaline, erect synnemata ≤35 µm diam., made of hyphae with 2–20 septa, with lateral branches at wide angles, all hyphae turning into apically branched conidiogenous cells, with a repeated asymmetrical bifurcating pattern, coralloid, at variable angles, openly disposed to very compact, sparsely septate, each branch 15–50 µm long, and ≤10 µm diam. at the inflated apical section, covered at maturity along their entire length with conidia.

Conidiogenesis holoblastic, more or less synchronous with minute denticles, 1–2 µm long.

Conidia globose to subglobose, hyaline, 4–6.5 µm, averaging ~5 µm diam. excluding warts, rarely ovoid or pyriform in moist conditions, 4 × 6.5(–8) µm, the wall cyanophilic, 0.5 µm thick, warted or tuberculate all over, warts, ≤0.3 µm high, evenly-spaced, 12–14 in median section.

Habitat. On soil, moss, and organic debris along paths under *Quercus* and *Fagus sylvatica* trees in forest.

Specimens examined: **BELGIUM, Walloon Brabant, Ottignies-LLN**, Lauzelle forest, on soil, moss, and organic debris along paths under *Quercus* and *Fagus sylvatica*, October 2017, coll. GL Hennebert (MUCL 56520, GenBank MK714923; MUCL 56524, GenBank MK714924; MUCL 56529, GenBank MK71492).

Anamorph of *Pachyphlodes citrina* (Berk. & Broome) Doweld, Index Fungorum 31: 1, 2013 Figs 2, 6B

Hyphal mats forming cushion-shaped or flattened patches, irregular in outline, somewhat in groups, 2–25 mm in diam., 1–2 mm high, white when young, discoloring to pale yellow ochre when mature, with a dense surface and fluffy margin, the largest patches bearing superficially droplets of translucent, glutinous, liquid gel, becoming orange flattened crust-like and brittle when dried.

Hyphae at first loosely interwoven and branched, smooth, hyaline, 3–6(–8) µm diam., with 2–15 septa, becoming fasciculate in hyaline, erect synnemata, ≤25 µm wide, the hyphae frequently anastomosed, laterally and apically branched, furcating repeatedly and asymmetrically, sparsely septate, each part 10–25 µm long and terminally inflated ≤8 µm wide, covered at maturity all along their length with conidia.

Conidiogenesis holoblastic, more or less synchronous with minute, denticles, 1 µm long.

Conidia globose to subglobose, hyaline, pale yellow ochre in mass, 4.5–7 µm, averaging ~5.2 µm diam., excluding warts, with a cyanophilic

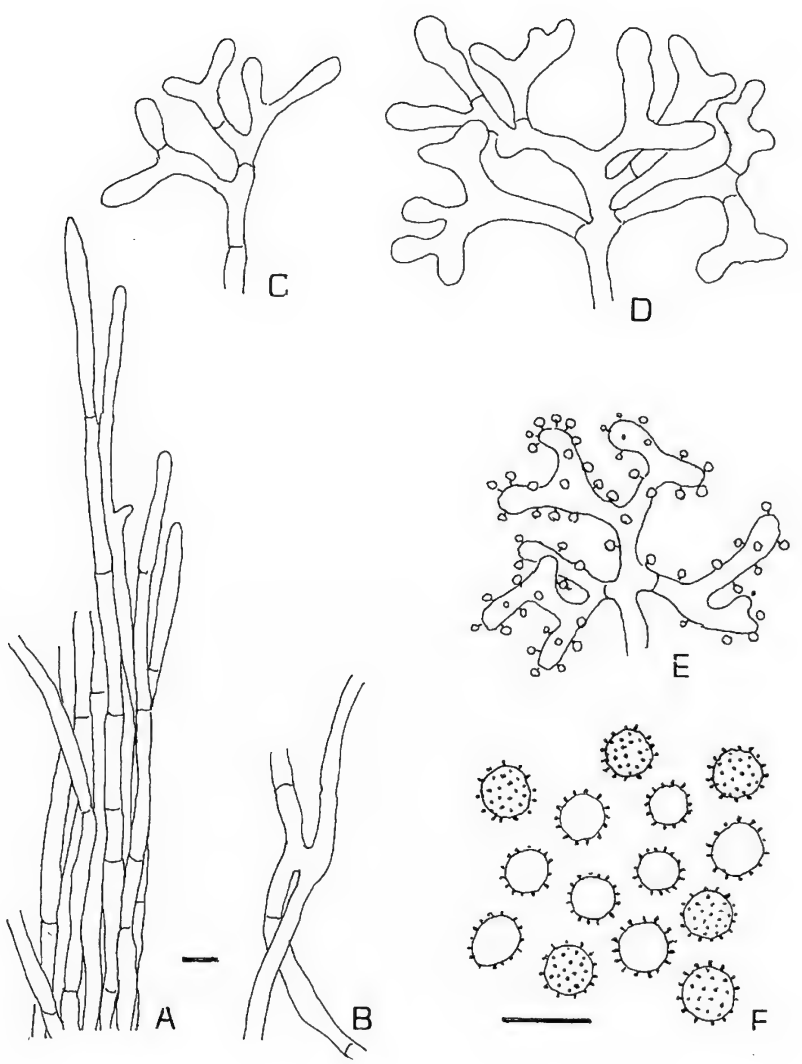

FIG. 2. *Pachyphlodes citrina* anamorph (MUCL 56652). A. Synnema. B. Anastomosis. C. Young branching. D. Developed branches. E. Conidiogenous branches. F. Conidia (Scale bars = 10 μm).

wall 0.5 µm thick, coarsely warted or baculate all over, warts cylindrical, apically blunt, ≤0.8 µm high, evenly spaced, 12–14 in median view.

Habitat. On soil along path near *Castanea* and *Larix* in forest.

Specimen examined: **BELGIUM, Walloon Brabant, Ottignies-LLN**, Lauzelle Forest, on soil along path near *Castanea* and *Larix* in Lauzelle forest, October 2017, coll. GL Hennebert (MUCL 56652, GenBank MK714926).

Anamorph of undetermined *Plicariella* sp. or *Pachyphlodes* sp. Figs 3, 6c

Hyphal mats forming cushion-shaped patches, determinate, irregular in outline, grouped, 1–5 mm in diam., 1–2 mm high, white when young to yellow ochre in color when mature, with surface fluffy to compacted and granulose, a few fresh mature patches bearing a droplet of translucent glutinous gel, forming a local orange flattened brittle crust when dried, the margin, if not the entire patch, remaining fluffy and granulose.

Hyphae at first loosely interwoven, smooth, hyaline, 3–7 µm diam., 2–10-septate, becoming fasciculate in hyaline erect synnemata ≤20 µm wide, becoming terminally branched through repeated and asymmetric bifurcations to form coralloid branch tips that are openly disposed or compacted and sparsely septate. Each part of branch is 10–70 µm long and inflated ≤8 µm, covered at maturity all along their length with conidia.

Conidiogenesis holoblastic more or less synchronous with minute denticles 1–1.5 µm long.

Conidia globose, hyaline, (3–)3.5–4.5 µm, most 4 µm diam., with a finely punctate wall.

Habitat. Soil, moss, and organic debris along path under mixed trees in forest.

Specimen examined: **BELGIUM, Walloon Brabant, Ottignies-LLN**, Lauzelle forest, on soil along path in, October 2017, coll. GL Hennebert (MUCL 56522, GenBank MK714927).

Original descriptions by Corda (1833)

Chromelosporium Corda and ***C. ochraceum*** Corda, Sturm's Deutschlands Flora. Abbildungen nach Natur., Abt. III Die Pilze, Bd. 3, p. 81, Tab. 41, 1833.

"**Chromelosporium** Corda

Char. Gen. Sporae continuae coloratae, in gelatinae nidulantes, floccis heterogeneis destructis ramosis, articulatis, hyalinis inspersae. Acervuli effuse colorati.

[Gen. char. Spores simple, colored, embedded in gel, hyphae dispersed, hyaline, heterogeneous, articulate, branches fragmented; mats extended, colored.]

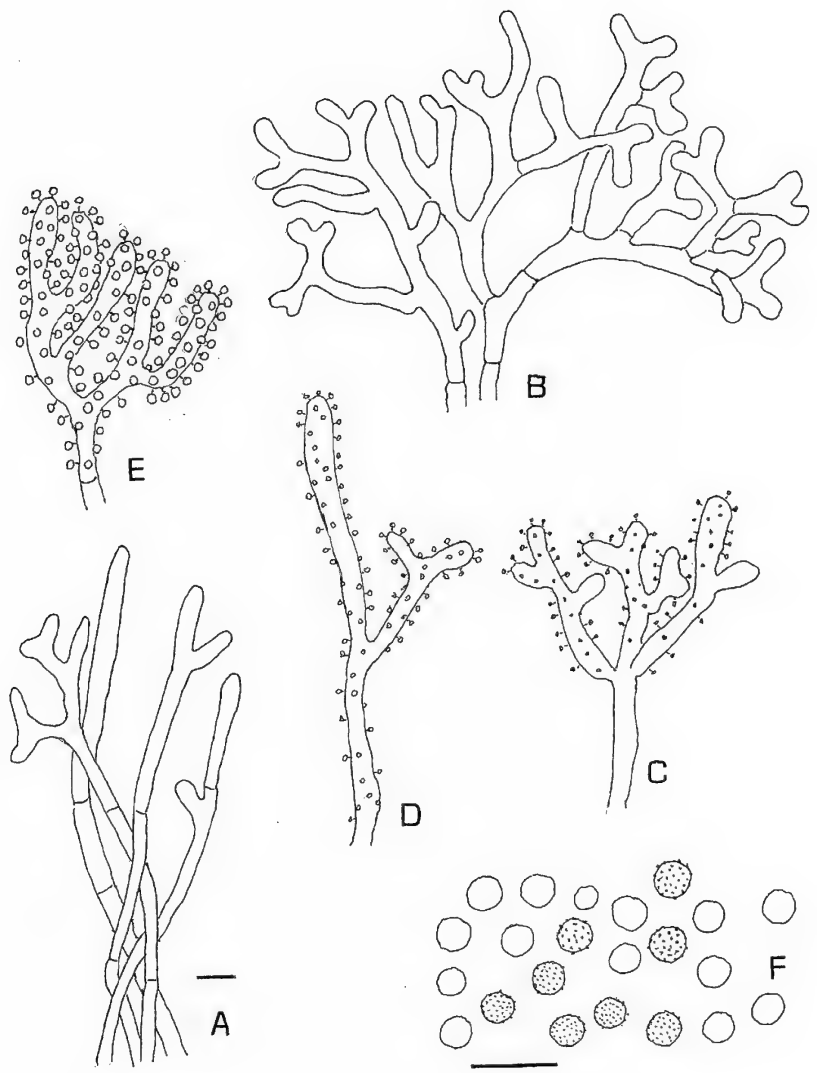

Fig. 3. *Plicariella* sp. or *Pachyphlodes* sp. anamorph (MUCL 56522).
A. Tip of synnema, B. Branching, C–E Conidiogenous hyphae. F. Conidia. (Scale bars = 10 µm).

Chromelosporium ochraceum Corda

Ocherfärbige Chromelosporie. Tab. 41

Ch. acervulis effusis ochraceis pulverulentis; sporis copiosissimis globosis ochraceis, gelatinae coloratae immersis; floccis hyalinis grosse-articulatis albis.

[Fungus cushion-like, effuse, ochre in color, pulverulent; spores very abundant, globose, ochre in color, immersed in a colored gel, dispersed in hyphae hyaline, white, branched and broadly articulate.]

Chr. mit verbreiteten ocherfärbigen, bestäubten Häufchen, sehr häufigen ocherfärbigen, mit gefärbten Schleim eingehüllten, kuglichen Sporen, und durchsichtigen, weissen, grossgegliederten Fäden.

Wohnt auf faulenden Stengeln der Liliaceen, verzüglich der *Hemerocallis* und *Allium,* 1827.

Die grossgegliederten, und nicht durch Scheidewände (septa) getheilten Fäden unterscheiden diese Gattung von *Sporotrichum,* so wie auch die gefärten Sporen, da *Sporotrichum* flocci septati (non articulati) und sporae homogeneae besitzt.

Die glashellen, weissen, grossgliedrigen, niederliegenden und verworrenen Fäden, sind wenig ästig, und im Vergliech zu ihren Sporen sehr gross und sparsam.

Die Sporen selbst sind nicht aus den Fäden entstanden, daher heterogen, sind kuglich, klein, sehr zahlreich, intensive ocherfarb, fast ziegelroth gefärbt. Die sind einfach, und nicht getheilt, auch sind sie durch einen im Wasser leicht lösslichen und gefärbten Schleim Häufchenartig an die Fäden befestigt.

[Ch. in extended, ochre, powdery mats, very often covered by a colored gel, spores globose, hyphae hyaline, in broad segments.

Habitat on rotten stems of *Liliaceae*, such as *Hemerocallis* and *Allium*. 1827.

The articulate and not septate hyphae distinguish this genus from *Sporotrichu*m, which also has colored spores, septate hyphae and homogeneous spores.

The hyphae are hyaline, articulate, prostrate, interwoven, sparsely branched and, compared to the spores, broad and sparse.

The spores themselves are not formed from the hyphae, thus heterogeneous. They are globose, small, very abundant, deep ochre, near reddish colored. They are simple, not septate; they are also fixed to the hyphae forming a kind of head by the colored gel slightly dissolved in water]

Tab. 41. A. Natûrliche Grösse. B. Fäden mit Sporen. C. Sporen noch stärker vergrössert. A. J. Corda."

Corda's second generic description (1842)

In Icones fungorum hujusque cognitorum, V, p. 8, Prague 1842, Corda gives a shortened description of *Chromelosporium* with a new comment:

Plate 4. *Chromelosporium ochraceum* Corda,
Sturm's Deutschl. Fl., III (Pilze), 3(13): 81, tab. 41, 1833

"**Chromelosporium** Corda, Sturm Fl. III, 13, p. 81.

Sporae continuae, coloratae, gelatinae immersae, floccis heterogeneis, articulatis, repentibus, ramosis, hyalinis inspersae.

K. Wir haben eine deutliche Schleimmasse gefunden, welche die Sporen und Flocken einhüllte."

[Spores simple, colored, embedded in gel, among hyphae heterogeneous, articulate, prostrate, branched, hyaline.

Comments. We have found a conspicuous mass of gel covering the spores and hyphae.]

Chromelosporium ochraceum re-examined

Chromelosporium ochraceum Corda,
Sturm's Deutschl. Fl., III (Pilze), 3(13): 81, tab. 41, 1833. Figs 5, 6d

Holotype: Czechoslovakia, Prague, "*Chromelo~~trichum~~*[crossed out]*sporium ochraceum* Ca. ramulis furcis, *Myrinema* generis" [scr. & del. A.C.J. Corda]. On *Allium* dead stem. (Herb. Corda in PRM 155414).

Colonies in small patches ≤10 mm, velvety, at first white then ochraceous when sporulating, made of two layers, one of conidiophores under one of terminal conidiogenous branches.

Conidiophores erect, mononematous, emerging from creeping hyphae, 3–5 µm diam. in the substratum, made of a bulbous basal cell, 28–35 × 12–15 µm, ochraceous, extending into a cylindrical, septate stipe, 100–400 µm long, light to ochraceous, the individual cells 40–95 × 10–14 µm, repeatedly branched, terminating with up to five dichotomous branches, each branch most often with a basal septum, and a second one next to the subsequent dichotomous branches, their length decreasing from one dichotomy to the next, usually the first basal dichotomy 40–90 × 9–10 µm, the second 30–70 × 6–10 µm, the third 30–50 × 6–9 µm, but in some cases dichotomies very short, decreasing from 20–10 µm, the range of angles in the dichotomies from 35–45°.

Conidiogenous cells comprising up to four terminal dichotomies, together 70–100 × 6–9 µm, often apically clavate to 11 µm diam., bearing conidia all along with small, denticles 2 × 1 µm, collapsing after conidial release, seceding at their basal septum, rarely leaving a frill on the last conidiophore cell.

Conidia holoblastic, borne singly on denticles, at maturity globose or subglobose, thick-walled, cyanophilic, verrucose, ochraceous to salmon in mass, 4–5.5 µm diam., ≤6 µm including warts, warts prominent and blunt, 12–18 in median view.

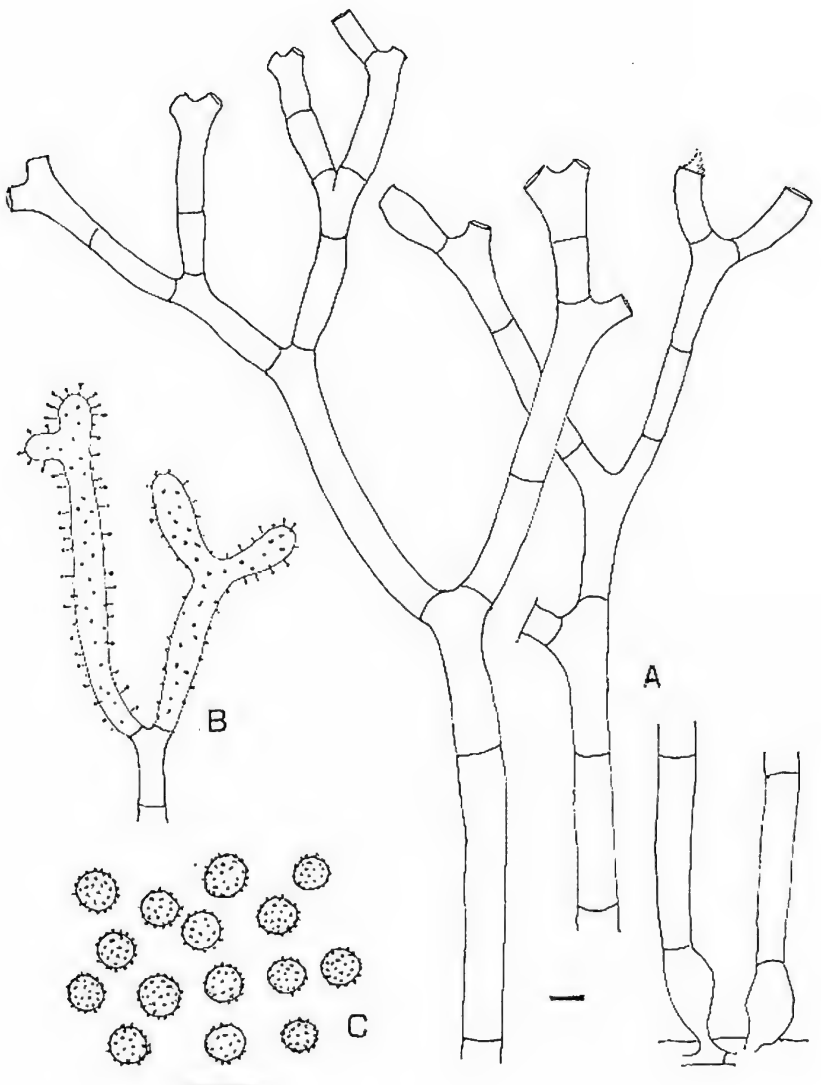

FIG. 5. *Chromelosporium ochraceum* Corda (Holotype PR 155414). A. Conidiophores stipes with basal cell and dichotomous branching. B. Terminal conidiogenous dichotomies. C. conidia (Scale bars = 10 µm).

Comments—The terms used by Corda interpreting his observations illustrated in Fig. 4 (Corda's fig. 41b) may raise some questions. The hyphae described as broadly articulate ("grosse-articulatis, grossegegliederten") appear in the figure to be hyphae distantly septate in long cells, drawn in their natural dichotomous position. Also the "ramis destructis" might refer to collapsed and disappeared conidiogenous branches after conidial release That would explain why Corda did not report attachments of the conidia to hyphae, which he said were heterogeneous ("floccis heterogeneis, sporen nicht aus den Fäden entstanden, daher heterogen"). The gel reported as colored ("gelatinae coloratae, gefärbten Schleim"), is translucent and may appear colored because of the embedded ochre spores. Our observations suggest that Corda noted those characters from an over-mature collection.

Discussion

Corda (1833, 1842) described *Chromelosporium ochraceum* with conidia embedded in a gel. However, this character was not considered significant by Hughes (1958) or Hennebert (1973) until Korf (1994) collected *Chromelosporium*-like specimens with a superficial gel and Healy (2015) noticed gel on anamorphic growth of *Pachyphlodes* spore-mats when crushed.

The gel, if noticed on fresh anamorphs in humid conditions, may appear on dried herbarium specimens as an orange spot, membranous and brittle, variable in size (as small as 2 mm) or may leave no traces, as is the case for the type specimen of *Chromelosporium ochraceum*. After the very dry summer of 2017, we observed gel droplets on only a few samples in shady places. In our opinion, the presence of gel is not a reliable, stable character, and its degree of development is probably circumstantial and dependent on environmental conditions.

The anamorphs of *P. nemoralis* and *P. citrina* are not yet described (R. Healy, pers. comm.). The anamorph of *Pachyphlodes pfisteri* Tocci & al., an endemic North American taxon, was described and illustrated with macro- and micro-photographs by Healy & al. (2015) and drawn by Hennebert (2017). Its conidiogenesis is in all respects identical to that of *P. nemoralis* and *P. citrina* (Figs 1, 2).

The anamorphs of the two *Pachyphlodes* and one undetermined *Pachyphlodes–Plicariella* species here described show distinctive features, particularly in hyphal width, conidiophore branching, and conidial size and ornamentation (Fig. 6). These characters should be examined in more *Pachyphlodes* and *Plicariella* species to evaluate their diagnostic value.

Although they have the same type of conidiogenesis, *Chromelosporium ochraceum*, the generic type species, differs significantly from *Pachyphlodes* and *Plicariella* in its anamorphic morphology. *Chromelosporium*, as demonstrated by *C. ochraceum*, has mononematous, erect apically branched conidiophores with regular dichotomies, each branch delimited by a septum, with up to four terminal dichotomies bearing holoblastic, synchronous conidia. *Pachyphlodes* and *Pachyphlodes–Plicariella* as shown here differ from *Chromelosporium* by creeping and erect, intermixed synnematous conidiophores, with lateral and apical coralloid branches that are sparsely septate and bearing holoblastic synchronous conidia along the entire length.

Conclusion

Differences found here between the anamorphs of *Pachyphlodes* species and the *Pachyphlodes–Plicariella* lineage and the anamorphs and the type species of *Chromelosporium* include synnematous versus mononematous conidiophores, apical and lateral branching versus solely apical branching, and spore production along most branches of the spore mat versus being limited to terminal hyphal branches. These differences might provide morphological evidence for maintaining *Chromelosporium* as a distinct genus from *Pachyphlodes.*

It remains to compare the morphologies of the still unknown anamorphs of *P. ligerica* (Tul. & C. Tul) Zobel, the type species of *Pachyphlodes* Zobel, and of *Plicariella radula* (Berk. & Broome) Rehm, the type species of *Plicariella* (Sacc.) Rehm, with the description provided here for *C. ochraceum* to confirm the morphological distinctiveness of the anamorphs of these lineages. The most expedient solution to answering the question of relatedness would be molecular analyses of *C. ochraceum* in its fresh anamorphic and/or sexual phases (yet to be discovered) and of the types of *Pachyphlodes* and *Plicariella.*

Another group of species presently named in *Chromelosporium, C. coerulescens* (Bonord.) Hennebert and *C. carneum* (Pers.) Hennebert, do not produce gel but form erect synnematous conidiophores, coralloid branching, and similar conidiogenesis (Hennebert 1973). These appear to be morphologically closer to the anamorphs of *Pachyphlodes–Plicariella* than to *Chromelosporium*. Genetic analysis should decide their taxonomic position in the *Pezizaceae*.

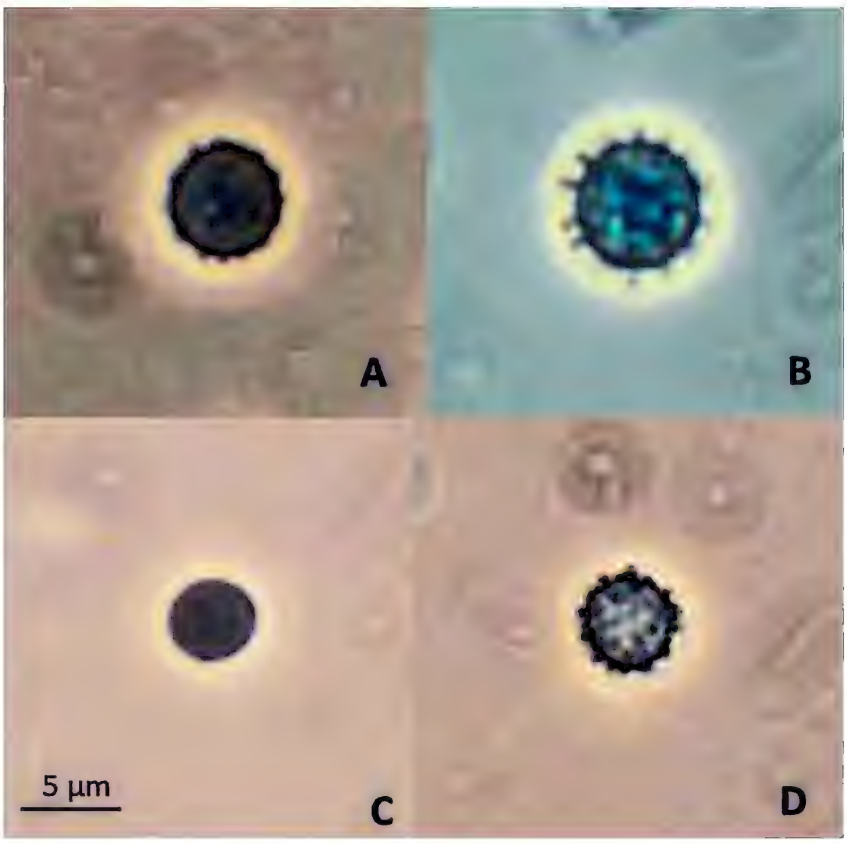

Plate. 6. Conidial ornamentation: A. *Pachyphlodes nemoralis* (MUCL 56524). B. *P. citrina* (MUCL 56652). C. *Plicariella* sp. or *Pachyphlodes* sp. (MUCL 56522). D. *Chromelosporium ochraceum* (Type PR 155414).

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Pseudosperma flavorimosum sp. nov. from Pakistan

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Abstract—*Pseudosperma flavorimosum* is a new species described from Khyber Pakhtunkhwa province, Pakistan. It is delimited based on morphological characters combined with a molecular phylogeny inferred from nuclear ribosomal DNA internal transcribed spacer (ITS) sequence analyses. The ITS-based phylogeny supports the independence of the new species, which is also is morphologically distinct from closely related taxa.

Key words—*Agaricales*, *Basidiomycota*, *Inocybaceae*, taxonomy

Introduction

Inocybaceae Jülich (*Basidiomycota*, *Agaricales*) is one of the larger families of agaric fungi with more than 700 species distributed worldwide (Matheny & al. 2009; Kropp & al. 2010; Bougher & Matheny 2011; Bougher & al. 2012; Fan & Bau 2013, 2014; Braaten & al. 2014; Esteve-Raventós & al. 2015; Jabeen & al. 2016; Farooqi & al. 2017; Matheny & Bougher 2017; Latha & Manimohan 2017; Ullah & al. 2018; Matheny & al. 2019). The number of species has increased considerably with the exploration of tropical and southern temperate areas. Many representatives of genera of *Inocybaceae* have been reported from Asia (Kobayashi & Onishi 2010; Fan & Bau 2013, 2014; Horak & al. 2015; Latha & Manimohan 2015, 2016, 2017; Saba & al. 2015; Jabeen & al. 2016; Pradeep & al. 2016; Farooqi & al. 2017; Naseer &

al. 2017; Liu & al. 2018; Ullah & al. 2018), with 24 species reported from Pakistan (Ahmad & al. 1997, Ilyas & al. 2013, Saba & al. 2015, Jabeen & al. 2016, Farooqi & al. 2017, Naseer & al. 2017, Liu & al. 2018, Ullah & al. 2018). All these species were previously placed in *Inocybe* (Fr.) Fr., but the recent classification by Matheny & al. (2019) distributes these taxa among separate genera.

Infrageneric classifications of *Inocybe* have been based on the morphology of the basidiospores, cystidia, and stipe (Kuyper 1986), with various morphological classifications proposed by different workers. Traditionally, *I.* sect. *Rimosae* was placed in *I.* subg. *Inosperma* (Kühner 1980, Kuyper 1986, Stangl 1989, Larsson & al. 2009). Larsson & al. (2009), who studied the phylogeny within *I.* sect. *Rimosae* using multigene DNA sequence analyses, found that *I.* sect. *Rimosae* comprised two strongly supported clades: /maculata and *I.* sect. *Rimosae* s. str. (sensu Larsson & al. 2009) The species in /maculata clustered with those in *I.* sect. *Cervicolores* and these two groups collectively represent *I.* subg. *Inosperma* s. str. *Inocybe* sect. *Rimosae* s. str. [corresponding with /pseudosperma of Matheny (2005)] has emerged as an independent clade, well distinguished from *I.* subg. *Inosperma* s. str. species of *I.* sect. *Rimosae* s. str. are characterized by the lack of metuloids and pleurocystidia and the presence of cylindrical to clavate cheilocystidia; smooth, radially appressed-fibrillose to rimose pilei; and smooth, elliptical to indistinctly phaseoliform basidiospores. In their recent revised classification, Matheny & al. (2019) recognize *I.* sect. *Rimosae* s. str. as an independent genus, *Pseudosperma* Matheny & Esteve-Rav., which we recognize here.

During 2012–2014 we wished to analyze fungal communities in coniferous forests of Khyber Pakhtunkhwa, Pakistan, that host a highly diverse mycota including mycorrhizal and non-mycorrhizal species. Here we identify one species in *Inocybaceae* based on morphological and molecular analyses and reveal the phylogenetic relationships among taxa.

Materials & methods

Morphological analysis

Basidiomata were collected from two administrative divisions of Pakistan. The first sampling site—Khanian, District Mansehra, Hazara Division, Khyber Pakhtunkhwa province—lies immediately south of the main Himalayan range with typical moist temperate climate and is dominated by *Cedrus deodara* along

with *Abies pindrow* (Royle ex D. Don) Royle, and *Pinus wallichiana*. (Siddiqui & al. 2013). The second site is Mashkun, a high mountainous region in the Swat district of Malakand division, Khyber Pakhtunkhwa province. The climate is dry temperate, and forests are dominated by *C. deodara* and *P. wallichiana*, with some *A. pindrow* also present (Champion & al. 1965).

Basidiomata were collected and photographed in their natural habitat. Morphological characters were recorded from fresh specimens. Color codes follow Munsell (1975). Each collection was preserved using hot air dryers. Tissues from dried basidiomata were rehydrated in 5% KOH prior to anatomical observation under a Meiji MX4300h light microscope. Crush mounts were prepared and stained with Congo red. The abbreviation (n/m/p) represents n number of basidiospores measured from m number of fruit bodies and p number of collections. Basidiospores were measured in lateral view. The dimensions were recorded as (a–)b–c(–d), where (a) = extreme minimum value, range b–c contains minimum of 90% of the calculated values and (d) = extreme maximum value, Q indicates l/w ratio of the spores and avQ = average Q of all spores. Other hyphal measurements are given as ranges. The examined specimens are deposited in the herbarium (LAH), Department of Botany, University of the Punjab, Quaid-e-Azam Campus, Lahore, Pakistan.

Molecular analysis

Genomic DNA was extracted and amplified according to White & al. (1990), Gardes & Bruns (1993), and Bruns (1995). The PCR products were purified and sequenced by Macrogen Inc. (Korea). The newly generated sequence was deposited in GenBank.

Sequences generated using forward and reverse primers were combined in the BioEdit software version 7.2.5 (Hall 1999) to obtain a consensus sequence. A sequence homology search was conducted using the BLAST algorithm (http://www.ncbi.nlm.nih.gov) on 25 May 2019. Complete ITS sequences that showed the maximum similarity and sequences of the putative closest relatives of our species according to the published literature were included in the final matrix (Larsson & al. 2009, Kropp & al. 2013, Latha & Manimohan 2017, Liu & al. 2018, Matheny & al. 2019) to reconstruct phylogeny. *Auritella foveata* C.K. Pradeep & Matheny (GU062740) served as outgroup following Larsson & al. (2009) and Matheny & al. (2019). Multiple sequences were aligned using the online webPRANK at EMBL-EBI (https://www.ebi.ac.uk/goldman-srv/webprank/). Maximum likelihood analysis was performed using General Time Reversible model (Nei & Kumar 2000) in MEGA version 6 (Tamura & al. 2013) at 1000 bootstrap pseudoreplicates by finding best-fit substitution model. A discrete Gamma distribution was used to model evolutionary rate differences among sites (5 categories (+G, parameter = 0.9359)). The rate variation model allowed for some sites to be evolutionarily invariable ([+I], 0.0000% sites).

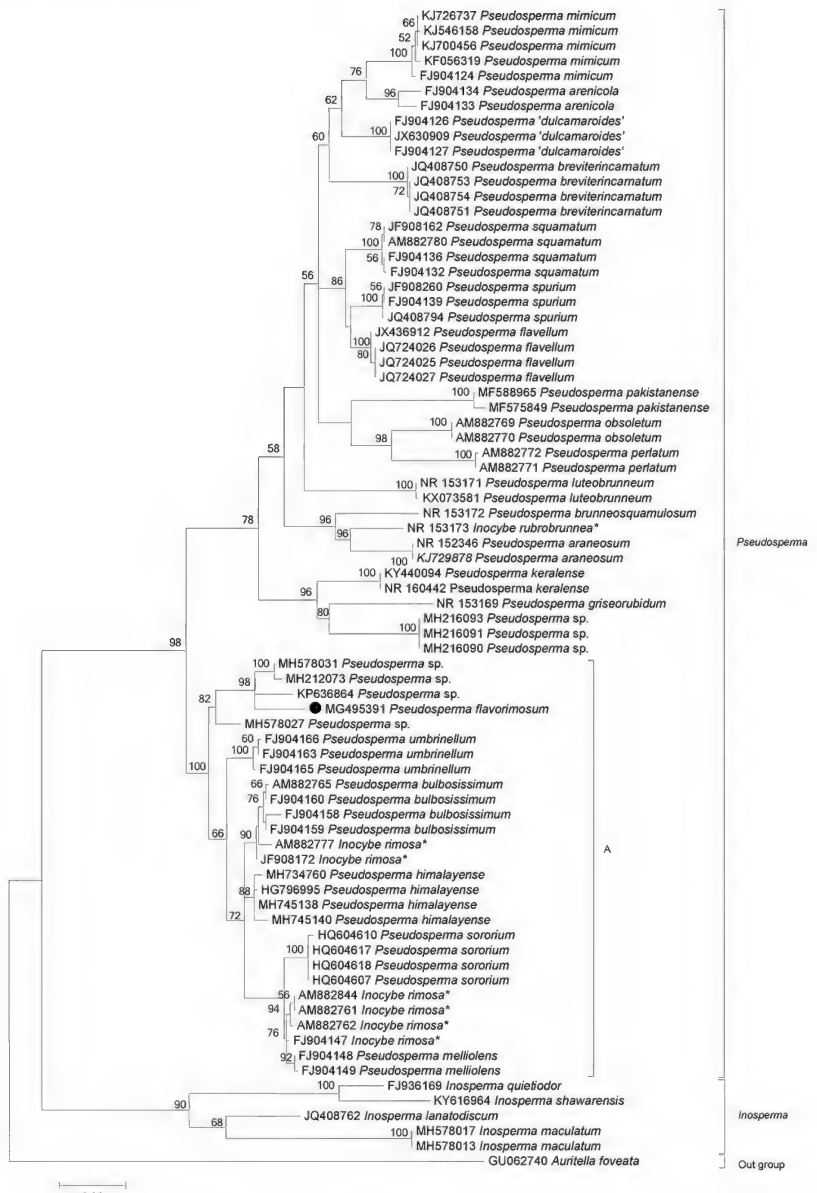

FIG. 1. Molecular phylogenetic analysis of *Pseudosperma flavorimosum* based on ITS sequences. Sequence generated during this study is marked by ●. Scale bar = nucleotide substitutions per site. The names of the taxa are written according to Matheny & al (2019). Those represented in quotes lack type specimens. * represents taxa that are not discussed in Matheny & al (2019) and given names according to their publication source and GenBank record.

Phylogeny

The NCBI BLAST search revealed that the *Pseudosperma flavorimosum* sequence (MG495391) shared 89–90% identity with unidentified "*Inocybe* sp." sequences (MH578031, MH578027, MH212073) from USA. Closely related ITS sequences were retrieved from GenBank for generating a phylogeny for the Pakistani taxon based on 77 nucleotide sequences. The final ITS matrix comprised a total of 1403 positions of which 734 were conserved, 442 were variable, 337 were parsimony informative, and 99 were singletons. The *P. flavorimosum* sequence forms a sister clade with unidentified *Inocybe* sequence KP636864, and both sequences clustered on the same branch with two more unidentified sequences (MH212073, MH578031) in the same clade as unidentified *Pseudosperma* sequence MH578027 with 82% bootstrap support and were separated from the clade containing *P. bulbosissimum* (Kühner) Matheny & Esteve-Rav., *P. himalayense* (Razaq & al.) Matheny & Esteve-Rav., *P. melliolens* (Kühner) Matheny & Esteve-Rav., *P. rimosum* (Bull.) Matheny & Esteve-Rav., *P. sororium* (Kauffman) Matheny & Esteve-Rav., and *P. umbrinellum* (Bres.) Matheny & Esteve-Rav. Our phylogenetic tree (Fig. 1) places the above *Pseudosperma* species in the same relationships as shown in Larsson & al. (2009, there as *Inocybe*) and Matheny & al. (2019).

Pseudosperma flavorimosum Jabeen & Khalid, **sp. nov.** Figs. 2, 3

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Differs from *Pseudosperma sororium* by its smooth ellipsoidal to slightly amygdaliform basidiospores with a broad base and narrow apex.

Type: Pakistan. Khyber Pakhtunkhwa province: Hazara division, Mansehra district, Kaghan valley (Khanian), 2500 m a.s.l., on soil under *Pinus wallichiana* A.B. Jacks., 3 Aug 2014, Muhammad Burhan SJ103 (**Holotype**, LAH35042; GenBank: MG495391).

Etymology: The specific epithet (Lat.) refers to the yellowish and rimose pileus.

Pileus 45–5.1 mm wide, initially conico-convex with a prominent umbo, becoming broadly conico-convex with a prominent umbo at maturity, umbo conical when young, becoming more obtuse in maturity, surface yellowish brown (10YR8/8) with dark brown (10R4/12) fibrillose streaks, dry, fibrillose, radially rimose towards the margin, margin incurved. Lamellae adnate to adnexed, moderately close, ≤2.5 mm deep, narrow, initially yellowish brown (10YR7/8), becoming dark brown (10R6/14) at maturity, edges fimbriate. Lamellulae in different lengths. Stipe 75 × 7 mm, central, cylindrical, narrower towards the apex and wider towards the base, apex furfuraceous, base splitting, surface dry, context off white under a yellowish (10YR8/8) to dark brown (5YR2/6) cuticle.

Basidiospores [40/2/2] (7.8–)9.5–12.8(–13.31) × (5.7–)6.3–7.8(–8.9) µm, Q = (1.21–)1.39–1.91(–1.98), avQ = 1.62, elliptical, amygdaliform with broad apex and narrow base, smooth, uniguttulate. Basidia (14.8–)26.4–31.2(–36.7) × (10.0–)10.5–10.8(–11.8) µm, clavate, 4-spored, thin-walled, guttulate. Cheilocystidia (18.5–)19.2–21.7(–25.3) × (7.5–)7.7–8.6(–9.1) µm, broadly clavate, thin-walled, frequently arranged on lamellar edges. Pleurocystidia absent. Pileipellis hyphae (3.8–)4.9–6.3(–6.6) µm diam., intricate trichoderm, non-encrusted, frequently septate, filamentous, fusoid terminals, clamped septa common, hyaline. Stipitipellis hyphae (4.5–)4.7–8.7(–9.2) µm diam., trichoderm, septate, filamentous, rarely branched, clamp connections not observed.

Ecology & distribution—among conifers in Himalayan moist and dry temperate forests; known only from Pakistan.

Additional specimen examined—**PAKISTAN. Khyber Pakhtunkhwa province: Malakand division**, Swat district, Mashkun, 2500 m a.s.l., on soil under *Cedrus deodara* (Roxb. ex D. Don) G. Don, 5 Sep 2013, Sana Jabeen MTI (LAH35043).

Discussion

Pseudosperma flavorimosum is characterized by its yellowish brown pileus with dark brown striations and radially rimose margins and a stipe with a rimose base and losing its stipitipellis over time. It is characterized with smooth ellipsoidal to slightly amygdaliform basidiospores with a broad base and narrow apex and broadly clavate cheilocystidia. ITS sequence analysis clusters *P. flavorimosum* with other *Pseudosperma* species. Taxa within the genus separated into several clades, with *P. flavorimosum* clustering in subclade A. *Pseudosperma melliolens*, described from France, also looks like a typical *P. rimosum* (Bull.) Matheny & Esteve-Rav. (Bon 1997).

Pseudosperma flavorimosum shares morphological similarities with *P. sororium,* as originally described by Kauffman (1924). But the elliptical or elongate-ellipsoid basidiospores of *P. sororium* are not truly subreniform, sub-inequilateral and are obtuse at both ends, distinguishing from *P. flavorimosum*.

Pseudosperma himalayense, a recently described taxon from Pakistan, differs morphologically from *P. flavorimosum* by its paler pileus (varying from white to cream, pale yellow, olive yellow, and light brown to camel brown) with dentate margins, ellipsoid to slightly amygdaliform basidiospores, and clavate to cylindrical cheilocystidia (Liu & al. 2018).

Pseudosperma umbrinellum bears yellowish to reddish brown pileus with a dark centre and strongly rimose and lighter periphery while *P. flavorimosum*

Fig. 2. *Pseudosperma flavorimosum* (LAH35042, holotype). Basidiomata. Scale bars = 1 cm. Photos by Sana Jabeen

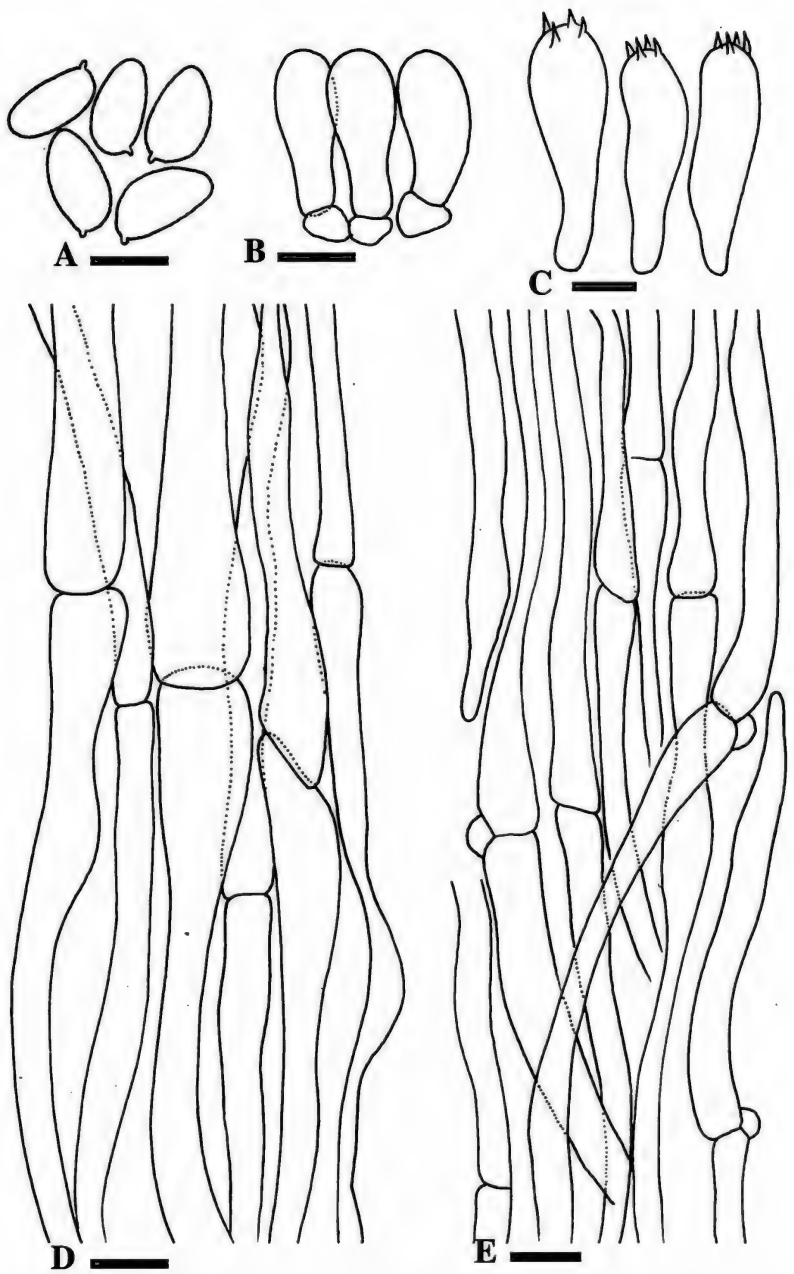

Fig. 3. *Pseudosperma flavorimosum* (LAH35042, holotype). A. Basidiospores; B. Cheilocystidia; C. Basidia; D. Stipitipellis; E. Pileipellis. Scale bars = 10 μm. Drawings by Sana Jabeen.

bears yellowish pileus with brown striations, but the anatomical features are identical to *P. rimosum*. The taxa adjacent to *P. flavorimosum* in the phylogenetic tree are undescribed morphologically but form separate lineages within subclade A of *Pseudosperma* with a strong bootstrap value supporting *P. flavorimosum* as a distinct taxon.

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Three *Rinodina* species new to China

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Abstract—*Rinodina ascociscana*, *R. subminuta*, and *R. trevisanii* are reported as new to China. A detailed description of each species is provided, and comparisons with related species are made.

Key words—*Ascomycota,* lichenized fungi, *Physciaceae*

Introduction

Rinodina (*Physciaceae*, *Caliciales*), which comprises more than 300 species worldwide (Sheard & al. 2017), occurs on rock, bark, mosses, soil, or debris and is characterized by a crustose thallus, mostly lecanorine apothecia with brown to black discs, a hyaline hymenium, a red-brown or (rarely) blue-grey epihymenium, clavate asci, and brown, primarily 1-septate (rarely 3-septate) to submuriform ascospores with ± unequally thickened walls (Mayrhofer & Moberg 2002; Sheard 2004, 2010).

Although many have recently contributed to crustose lichen diversity in China (e.g., Kou & al. 2013, Ren & Zhao 2014, Ren 2017, Ren & al. 2018, Zhou & Ren 2018), knowledge of *Rinodina* species remains poor in this country. Forty-five species and three forms have been reported from China (e.g., Mayrhofer 1984; Wei 1991; Abdulla & Wu 1994, 1998; Aptroot & Seaward 1999; Aptroot & Sipman 2001; Aptroot & Sparrius 2003; Joshi & al. 2014; Kondratyuk & al. 2016; Sheard & al. 2017). During a survey of *Rinodina* specimens, we detected three species new for China: *Rinodina ascociscana*, *R. subminuta*, and *R. trevisanii.*

Materials & methods

The specimens examined in this study were housed in SDNU (the Plant Herbarium of Shandong Normal University, Jinan, China) and HMAS-L (Herbarium of Mycology, Chinese Academy of Sciences, Beijing, China).

Morphological and anatomical characters were observed using an Olympus SZ51 stereo microscope and an Olympus CX21 light microscope. Lichen substances were detected by thin layer chromatography (TLC) with solvent systems A, B,, and C (Elix 2014). Photos were taken using Olympus SZX16 and BX61 microscopes with a DP72 digital camera. We identified the specimens primarily from Sheard & al. (2017).

Species

Rinodina ascociscana (Tuck.) Tuck., Gen. Lich.: 124 (1872). FIG. 1

THALLUS crustose, thick, well-developed, surface continuous, ochraceous to brownish; prothallus absent; vegetative propagules absent.

APOTHECIA lecanorine, not erumpent, 0.5–1.2 mm in diam, scattered, sessile, narrowly attached; DISC brown to black, epruinose, persistently plane, thalline margin concolourous with thallus, often with radially cracked, sometimes becoming flexuous; excipular ring present, confluent, prominent, darker than thalline margin. THALLINE EXCIPLE 50–80 µm wide; proper exciple hyaline, 15–25 µm wide; HYMENIUM hyaline, 80–110 µm high, paraphyses 2–3 µm in diam.; EPIHYMENIUM red-brown, 10–20 µm high; HYPOTHECIUM hyaline, 20–40 µm deep. ASCI clavate, 8-spored; ASCOSPORES brown to dark brown, type A development, *Physcia*-type, ellipsoid, 1-septate, 27.5–35 × 12.5–15 µm, torus absent, ornamented walls not evident. PYCNIDIA not seen.

CHEMISTRY—No lichen substances detected by TLC.

SPECIMENS EXAMINED: **CHINA. JILIN: Antu County**, c. 30 km from Erdaobaihe town toward Changbaishan mountain and lake, alt. c. 1100 m, on bark of conifer tree, 2011.09, Sohrabi with Ghobad-Nejhad 16644 (HAMS-L 120853); **Helong City**, Mt. Zengfeng, alt. 1600 m, on bark of deciduous trees, 2011.08.19, Y.L. Cheng 20119406A, 20119440B, 20119844 (SDNU).

SUBSTRATE & DISTRIBUTION—*Rinodina ascociscana* occurs on bark of conifers or deciduous trees in mixed forests with *Acer*, *Abies*, and *Larix*. It was previously known from North America (Sheard 2010) and north-eastern Asia (Japan, Siberia, and South Korea; Sheard & al. 2017); new from China.

COMMENTS—Our material closely matched the descriptions of Sheard (2010) and Sheard & al. (2017). *Rinodina ascociscana* is characterized by the often radially cracked thalline margin, the large *Physcia*-type ascospores

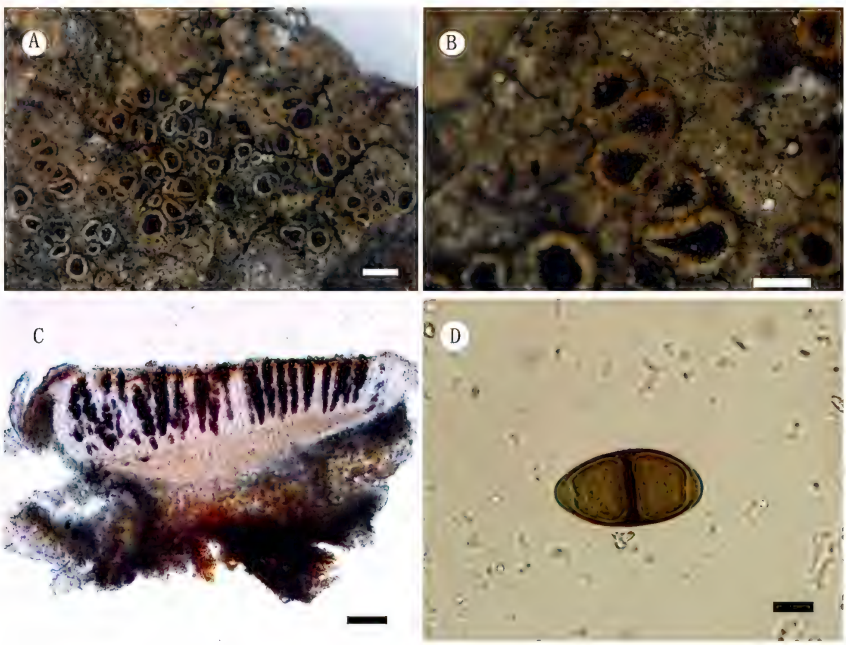

Fig. 1. *Rinodina ascociscana* (SDNU, Cheng 20119844). A. Thallus with substratum; B. Apothecia showing radially cracked thalline margin; C. Section of apothecium; D. Immature *Physcia*-type ascospore; E. *Physcia*-type ascospore mature. Scale bars: A = 1 mm; B = 0.5 mm; C = 100 μm; D, E = 10 μm.

with type A development, and the absence of lichen substances. *Rinodina dolichospora* Malme differs by its thalline margin that is not radially cracked and *Pachysporaria*-type I ascospores (Sheard 2010).

Rinodina subminuta H. Magn., Bot. Not. 1947: 44 (1947). Fig. 2

Thallus crustose, thin to endophloeodal, continuous to rimose, surface matte or glossy, yellowish or light to dark grey; prothallus absent; vegetative propagules absent.

Apothecia lecanorine, erumpent; disc black, epruinose, plane, sometimes convex, 0.4–0.65 mm in diam; thalline margin concolourous with thallus, excipular ring absent. Thalline exciple 50–80 μm wide; proper exciple hyaline, 15–25 μm wide; hymenium hyaline, 60–80 μm high, paraphyses 2.5–4.5 μm in diam.; epihymenium red-brown; hypothecium hyaline, 30–60 μm deep. Asci clavate, 8-spored, 45–70 × 20–30 μm;

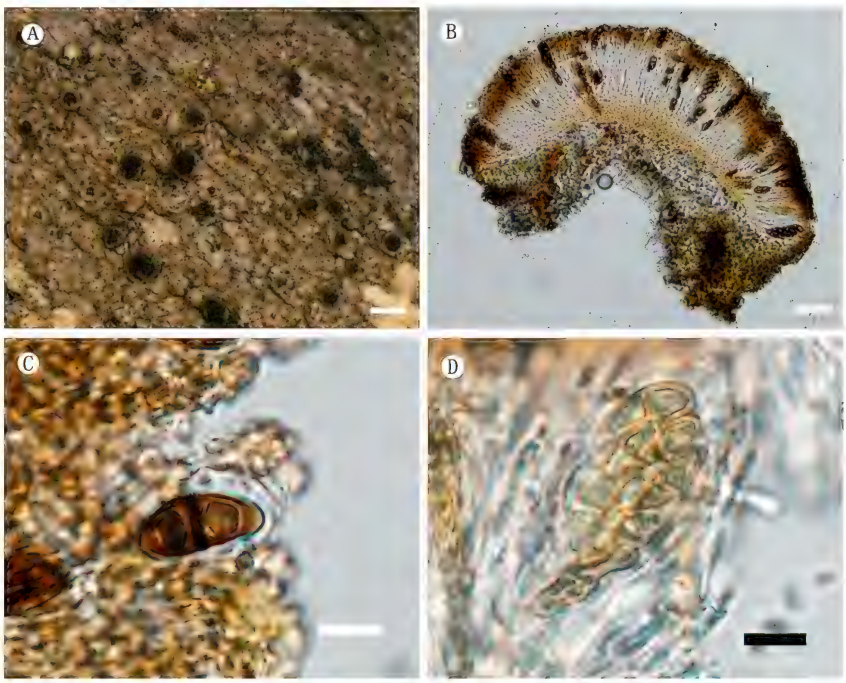

Fig. 2. *Rinodina subminuta* (HMAS-L 073131). A. Thallus with substratum; B. Section of apothecium; C. Mature ascospore. Scale bars: A = 0.5 mm; B = 50 μm; C = 10 μm.

ascospores brown, type A development, ellipsoid, 1-septate, *Physcia*-type, 17–20(–22.5) × 8–9.5(–10) μm, torus present, ascospore walls not ornamented. Pycnidia not seen.

Chemistry—Zeorin, ± one unknown substance with UV+ blue (TLC: A=7, B=7, C=7).

Specimens examined: **CHINA. Jilin: Mt. Changbai**, Tianchi, alt. 1850 m, on *Betula ermanii* Cham. (*Betulaceae*), 1984.08.14, X.D. Lu 848410-1 (HMAS-L 0141286); Hot spring, on *Betula ermanii*, 1994.08.06, Wei & al. 94423 (HMAS-L 073131); South Slope, alt. 1900 m, on *Betula ermanii*, 1983.08.03, J.C. Wei & J.B. Chen 6586-1 (HMAS-L 0141288); on *Betula ermanii*, 2003.8.20, H.M. Li CBS114-1 (HMAS-L 0141273); North Slope, alt. 1810 m. on *Sorbus* sp. (*Rosaceae*), 2018.08.19, Q. Ren 7119, 7120 (SDNU); on *Betula ermanii*, 2018.08.19, Q. Ren 7029, 7040 (SDNU).

Substrate & distribution—*Rinodina subminuta* occurs on the bark of *Betula ermanii* and *Sorbus* sp. in open sites of deciduous forests. It was previously known from North America and Siberia (Sheard 2010), and from north-eastern Asia (Japan, Siberia, and South Korea; Sheard & al. 2017); new from China.

Comments—Our material closely matches the description in Sheard (2010). *Rinodina submminuta* is characterized by a thin thallus, erumpent apothecia, *Physcia*-type ascospores with type A development, and the presence of zeorin. *Rinodina orientalis* Sheard differs by strongly convex discs of mature apothecia, smaller ascospores (16–18 × 7–8.5 μm), and the absence of lichen substances (Sheard & al. 2017).

Rinodina trevisanii (Hepp) Körb., Parerga Lichenol.: 70 (1859) Fig. 3

Thallus crustose, very thin, surface continuous to rimose, brownish; prothallus absent; vegetative propagules absent.

Apothecia lecanorine, not erumpent, 0.4–0.6 mm in diam, sessile, broadly or narrowly attached; disc brown to black, epruinose, plane, frequently becoming convex, thalline margin concolourous with thallus, often becoming excluded or margin biatorine, excipular ring not prominent. Thalline exciple 50–70 μm wide; proper exciple hyaline, c. 15 μm wide; hymenium hyaline, 65–80 μm high, paraphyses 1.5–2.5 μm in diam.; epihymenium red-brown, 10–30 μm high; hypothecium hyaline, 30–110 μm deep. Asci clavate, 8-spored, 50–60 × 17.5–30 μm; ascospores brown, type A development, *Physconia*-type, ellipsoid, 1-septate, 18–22.5(–23.5) × 8–9.5(–10) μm, torus sometimes present but not prominent, ascospore walls not ornamented. Pycnidia not seen.

Chemistry—±Zeorin.

Specimens examined: **CHINA. Heilongjiang: Heihe City**, Mt. Xifeng, alt. 220 m, on bark, 2009.08.17, Q. Ren 1192 (SDNU); **Mohe City**, Mt. Guanyinshan, alt. 554 m, on bark, 2009.08.13, Q. Ren 1179 (SDNU); **Tahe City**, Mt. Baikalu, alt. 800 m, on bark, 2011.08.25, Y.L. Cheng 20125237B (SDNU); Daxing'anling, alt. 800 m, on tree trunk, 1984.08.07, X.Q. Gao 105 (HMAS-L 072400). **Jilin: Antu City**, Mt. Changbai, alt. 1750 m, on *Larix* sp. (*Pinaceae*), 1984.08.28, X.D. Lu 848421-5 (HMAS-L 076349); North Slope of Mt. Changbai, alt. 1810 m. on *Betula ermanii*, 2018.08.19, Q. Ren 7118 (SDNU).

Substrate & distribution— *Rinodina trevisanii* occurs on bark of *Larix* sp., *Betula ermanii*, and other trees in mixed forests. It was previously known from Europe, Asia (Caucasus, Turkey, Siberia), western North America (Mayrhofer & Sheard 2007, Sheard 2010), Kazakhstan (Hauck & al. 2013a), and western Mongolia (Hauck & al. 2013b); new from China.

Comments—Our material closely corresponds with the description of Sheard (2010). *Rinodina trevisanii* is characterized by a thin thallus, mostly scattered apothecia with frequently convex discs and margins often biatorine, and *Physconia*-type ascospores with type A development. *Rinodina archaea*

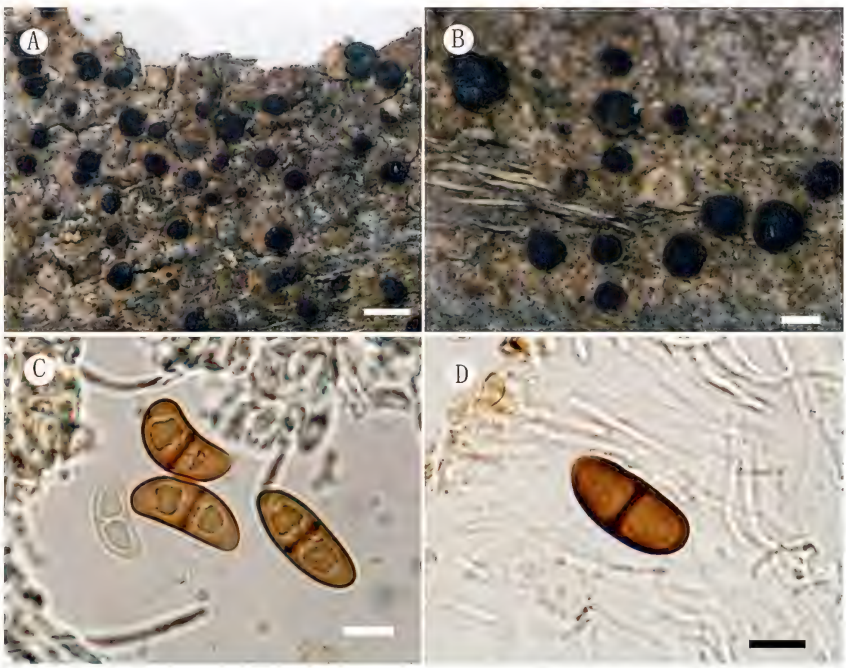

Fig. 3. *Rinodina trevisanii* (HMAS-L 076349). A, B. Thallus with substratum; C. Immature ascospores; D. Mature ascospore. Scale bars: A = 1 mm; B = 0.5 mm; C, D = 10 μm.

(Ach.) Arnold differs by its relatively thick, typically areolate thallus, often compressed (hence angular) apothecia, persistently plane discs of mature apothecia, and larger ascospores (Mayrhofer & Sheard 2007).

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Gymnopus barbipes and *G. dysodes*, new records for Pakistan

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Abstract—Morphological and phylogenetic analyses were conducted to identify *Gymnopus* species collected in Pakistan during 2013–14. Phylogenetic analysis was performed using internal transcribed spacer region (ITS) of ribosomal DNA sequences. Among the collected taxa, we identified *Gymnopus barbipes* and *G. dysodes,* represent new records for Pakistan. Their detailed descriptions and illustrations are also provided.

Key words —Khyber Pakhtunkhwa, *Omphalotaceae*, pine forests

Introduction

Gymnopus (Pers.) Roussel (*Omphalotaceae*, *Agaricales*) is a large fungal genus, which consists of c. 300 species distributed worldwide (Jang & al. 2016). It is characterized by a collybioid basidioma; a convex to applanate or slightly concave pileus; free, emarginate or adnate and crowded to fairly distant lamellae; a central stipe; a white spore print; inamyloid or non-dextrinoid hyphae with clamp connections; ellipsoid to oblong, thin-walled, hyaline, inamyloid basidiospores. Cheilocystidia are often present while pleurocystidia are usually absent (Antonín & al. 2013, Jang & al. 2016, Saba & Khalid 2014). Seven species of *Gymnopus*—worldwide a relatively common

saprobe on leaf litter and dead wood—have been reported in Pakistan (Ahmad 1980, Iqbal & Khalid 1996, Shibata 1992, Sultana & al. 2011, Saba & Khalid 2014). In view of the high worldwide diversity, we would expect the diversity of Pakistani *Gymnopus* to be much greater than currently reported.

To explore the diversity of indigenous *Gymnopus* spp., we collected specimens in Pakistan, which we identified through morphological and phylogenetic analyses. Here we report *Gymnopus barbipes* and *G. dysodes* as new records for Pakistan.

Materials & methods

Morphological evaluation

Basidiomata were collected, photographed, characterized morphologically, dried, and deposited in the University of Swat Herbarium (SWAT) in Pakistan and Farlow Herbarium of Harvard University in USA (FH). Color designations are from Munsell (1975). Microscopical observations were made from slide preparations from dried specimens mounted in 5% potassium hydroxide (KOH) or Melzer's reagent under a Meiji Techno MX4300H biological microscope. Dimensions of anatomical features (basidiospores, basidia, cystidia, hyphae) were calculated from at least 25 measurements using an ocular micrometer and 100× oil-immersion objective with x = arithmetic means of spore lengths and widths for all spores measured. Line drawings were made with a camera lucida.

DNA extraction, PCR amplification, DNA sequencing

Genomic DNA was extracted from a small piece of basidioma by a modified CTAB method (Lee & al. 1988) using the Qiagen DNeasy Plant Mini Kit (cat. no. 69104). The entire rDNA internal transcribed spacer region (ITS = ITS1+5.8S+ITS2) was targeted with primer pair ITS1F/ITS4 (White & al. 1990, Gardes & Bruns 1993) and then amplified using Econo Taq DNA Polymerase following the PCR cycling parameters: initial denaturation (94 °C for 1 min), 35 cycles (94 °C for 1 min, 53 °C for 1 min, 72 °C for 1 min), and final extension (72 °C for 8 min). The PCR amplicons were sent to Macrogen (Republic of Korea) for purification and bidirectional sequencing.

Sequence alignment & phylogenetic analysis

The ITS sequence of MSM0034 comprised 700 base pairs and that of ING-21 comprised 691 base pairs. We retrieved closely related ITS sequences via a BLAST search of GenBank for subsequent phylogenetic analysis, according to Saba & Khalid (2014). Sequences used in phylogenetic construction are shown in Table 1.

Sequences were manually edited and assembled using BioEdit (www.mbio.ncsu.edu/bioedit/bioedit.html). Following Dentinger & al. (2011) for complete ITS sequences, all sequences were trimmed with the conserved motifs 5′–(...GAT) CATTA– and –GACCT (CAAA...)–3′ with the enclosed aligned portions analysed. Sequences of

Table 1: *Gymnopus* and *Omphalotus* ITS sequences analyzed. New sequences in **bold**.

Taxon	Country	GenBank #	Collection/Voucher #
G. barbipes	**Pakistan**	**MK450334**	**MSM 0034**
	USA	KJ416265	TENN **69173**
	USA	KJ416266	TENN **69173**
	USA	KJ416269	TENN **67858**-T
G. biformis	Costa Rica	DQ450064	TFB7843
	Costa Rica	DQ450063	TFB7820
G. confluens	Russia	AY256697	TENN58242
	—	HM240527	UBC F19677
G. cylindricus	Costa Rica	AY256696	TENN58024
	Costa Rica	DQ450057	TFB10091
G. dryophilus	Italy	JX536157	BRNM707149
G. dysodes	**Pakistan**	**MT114698**	**SWAT 001355**
	USA	AF505778	TENN 59141
	USA	KY026666	TENN F-61125
	Czech Republic	JX536158	BRNM712600
G. erythropus	Slovakia	DQ449996	SAV XI2002
	USA	DQ449998	WTU JFA12910
G. fibrosipes	Costa Rica	AF505763	TENN56660
	—	AY842953	PR23TN
G. fusipes	France	AY256710	TENN59217
	Austria	AF505777	TENN59300
G. gibbosus	—	AY263437	AWW66
	—	AY263438	AWW95
G. impudicus	Russia	KJ416263	TENN 60094
	Russia	KJ416264	Culture
G. luxurians	Pakistan	KF803760	MSM 001
	Pakistan	KF803761	MSM 002
	USA	AY256709	TENN57910
	Switzerland	DQ450022	TENN50619
G. menehune	Pakistan	KF803762	MSM 003
	—	JN182864	—
	—	AY263426	DED5866
G. mesoamericanus	Costa Rica	DQ450036	TENN58106
	Costa Rica	AF505768	NYBG REH7379
G. polygrammus	Puerto Rico	DQ450028	TENN56589
	—	AY842954	PR 2542TN
G. readiae	New Zealand	DQ450034	TENN53687
	New Zealand	HQ533036	PDD95844
G. subcyathiformis	Puerto Rico	DQ450041	TENN58130
	Dominican Republic	DQ450042	TENN59550
G. subpruinosus	USA	DQ450026	TENN56242
	USA	DQ450027	TENN59477
O. illudens	USA	AY313271	TENN54507
O. olearius	France	AY313277	Culture 9061b
O. olivascens	USA	AY313281	TENN55337

Omphalotus spp. were used as outgroup based on results reported by Moncalvo & al. (2002) and Mata & al. (2004).

We aligned our new sequences with GenBank sequences from related taxa using ClustalX (Thompson & al. 1997) and manually edited where necessary using BioEdit (Hall 1999). A maximum likelihood analysis was performed via CIPRES Science Gateway (Miller & al. 2010) employing RAxML-HPC v.8 and Rapid bootstrap analysis/search for best scoring, with the topology assessed by 1000 bootstrap replicates.

Taxonomy

Gymnopus barbipes R.H. Petersen & K.W. Hughes,
N. Amer. Fung. 9(3): 2 (2014). FIG. 1

Pileus 25 mm diam., broadly convex, expanding with age to plane, flat, thin; margin straight; surface matte, smooth; central disc brownish orange (5YR5/8) to strong brown (5YR4/6) or light brown (5YR8/8). Lamellae adnexed or free, subdistant, light orange (2.5YR8/8), edges even, concolorous. Lamellulae 1–2 tiered. Stipe 40 × 5 mm, central, equal, cylindrical, hollow, sheathed in a thin, off-white, felty covering, brownish orange (5YR5/8). Odor & taste not distinctive.

Basidiospores 5–7 × 2.3–4 µm [x = 5.6 × 3.0 µm, Q = 1.2–1.6], ellipsoid in profile view, slightly flattened adaxially, rarely ovoid, smooth, thin-walled, aguttulate, hyaline in KOH, inamyloid. Basidia 23–28 × 5–6 µm, clavate, 4-spored (rarely 2-spored) basidia, thin-walled, hyaline in KOH; sterigmata 3–3.7 µm. Basidioles subclavate, abundant. Pleurocystidia absent. Cheilocystidia abundant, sometimes constricted at neck. Pileipellis a cutis, repent hyphae cylindrical, 5–14 µm, thin-walled, hyaline in KOH. Stipe hyphae cylindrical, 5–9 µm, non-encrusted, hyaline in KOH. Caulocystidia cylindrical, knobby, abundant, hyaline, thin-walled, 9–14 µm in diam. Clamp connections present in all tissues.

MATERIAL STUDIED: **PAKISTAN**, **KHYBER PAKHTUNKHWA**, **Shangla**, Yakh Tangay, under *Pinus wallichiana* A.B. Jacks., 2 September 2013, Malka Saba & Abdul Nasir Khalid, MSM#0034 (FH00304574; GenBank MK450334).

COMMENTS—Our Pakistani specimen agrees morphologically with the original protologue of *G. barbipes* except for its broader pileus (cited as 5–15 mm diam. in Petersen & Hughes 2014), robust stipe, and presence of ovoid basidiospores in addition to ellipsoid basidiospores. *Gymnopus barbipes* was described from southeastern North America and characterized by its occurrence on leaf litter and absence of well-developed pleurocystidia and cheilocystidia (Petersen & Hughes 2014). Our Pakistani collection

Fig. 1. *Gymnopus barbipes* (MSM 0034). A, B. Basidiomata; C. Basidia; D. Cheilocystidia; E. Basidiospores; F. Caulocystidia; G. Pileipellis. Scale bars: A, B = 10 mm; C, D = 10 µm; E = 5 µm; F, G = 25 µm.

represents the first occurrence of *G. barbipes* reported since the Tennessee collection was described.

Gymnopus dysodes (Halling) Halling, Mycotaxon 63: 364 (1997). FIG. 2

≡ *Collybia dysodes* Halling, Mycol. Mem. 8: 79 (1983).

Pileus 15–30 mm across, conic to campanulate at first, later plano-convex to plane, color light pinkish brown (5YR 6/4) to pale reddish brown (5YR 4/4) with a darker (7.5YR 1/2) disc, surface dry, dull, disc smooth, otherwise sulcate, pileus margin crenate or eroded in some specimens, context thin, 1–2 mm at the disc, ≤1mm at the margins, flesh pinkish brown (7.5YR 9/4), unchanging when cut. Lamellae adnexed, seceding, narrow (1.5–2.5 mm) wide, distant, initially creamy pinkish (5Y 9/4), becoming light brown (7.5YR 7/4) and finally dark brown (5Y 3/4). Lamellulae present, rare, short, mostly in single tier. Stipe 10–20 × 4–7 mm, cylindrical in young specimens, compressed in mature specimens, equal to thickening downward, surface reddish brown (7.5 YR 9/4), smooth or slightly scaly with hirsute base, interior hollow at the center, pith at apex and in base whitish fibrillose, concolorous with stipe surface, unchanging when cut. Odor of garlic. Taste not noted.

Basidiospores 7.3–8.6 × 3.4–3.9 µm, [x = 7.9 × 3.7 µm, Q = 1.8–2.4], narrowly ellipsoid to oblong, smooth, thin-walled, hyaline in both KOH and Congo Red, inamyloid. Basidia 22–25 × 4–6 µm, clavate, with four sterigmata, thin-walled, hyaline in KOH. Basidioles subclavate to cylindrical, numerous. Cheilocystidia 25–35 × 5–7 µm, variously shaped, cylindrical, narrowly utriform or fusoid, flexuous, bottle shaped, horned/rostrate, thin-walled, clamped at bases, hyaline in KOH. Pleurocystidia absent. Pileipellis a cutis, individual hyphae 5–10 µm diam., terminals mostly acute, some cylindrical, others with irregular terminals, thin-walled.

MATERIAL STUDIED: **PAKISTAN**, **KHYBER PAKHTUNKHWA**, **District Swat**, village Ingaro Dherai, in clusters on decaying woodchips of deciduous trees, 23 July 2014, Junaid Khan, ING-21 (SWAT 001355; GenBank MT114698).

COMMENTS—Our Pakistani specimen agrees morphologically with the original protologue of *Collybia dysodes* by Halling (1983). *Gymnopus dysodes* falls within *G.* sect. *Impudici,* characterized by an unpleasant smell resembling rotten cabbage, onion, garlic, etc.

Gymnopus dysodes, a North American species, is characterized mainly by its lignicolous habit, dark reddish brown to cinnamon brownish basidiomata, cinnamon brown lamellae, dark to light reddish brown stipe, a pungent

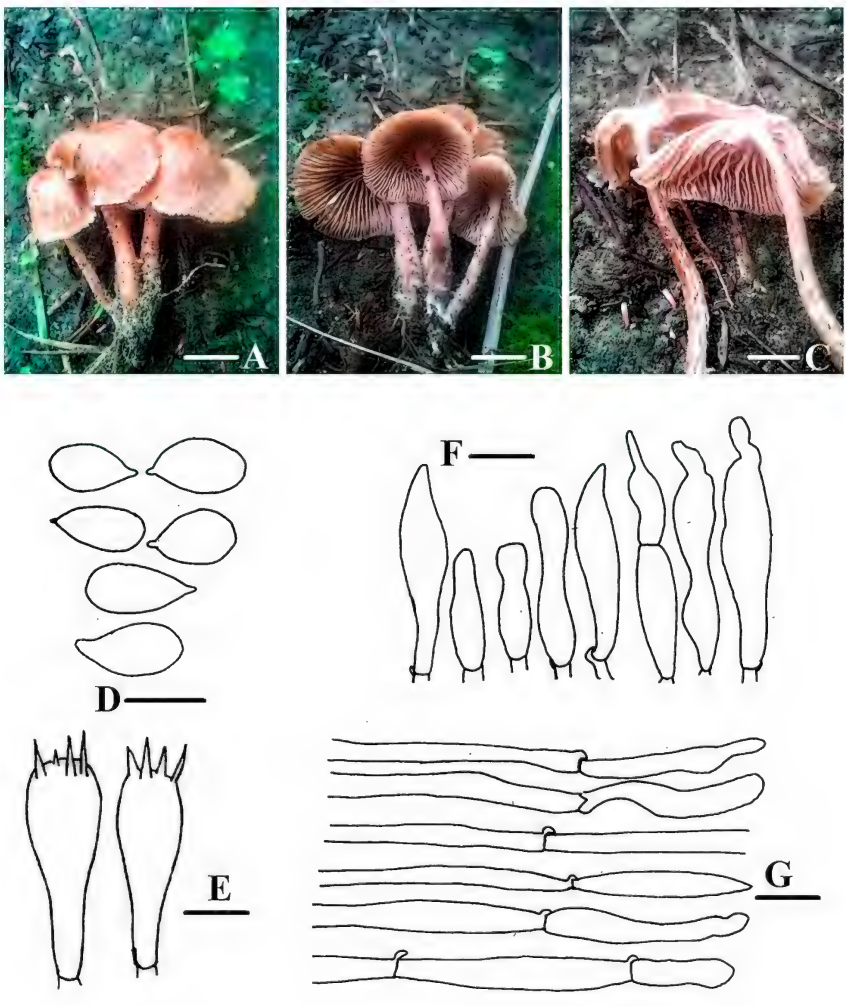

Fig. 2. *Gymnopus dysodes* (ING-21). A–C. Basidiomata; D. Basidiospores; E. Basidiole and basidium; F. Cheilocystidia; G. Pileipellis hyphae (with clamped septa). Scale bars: A–C = 5 mm; D, E = 5 μm; F = 10 μm; G = 15 μm.

garlic-like odour, and cylindrical to flexuous cheilocystidia (Halling 1983). Our collection was also collected on decaying wood chips of deciduous trees; both morphology and sequence analysis support its identification as

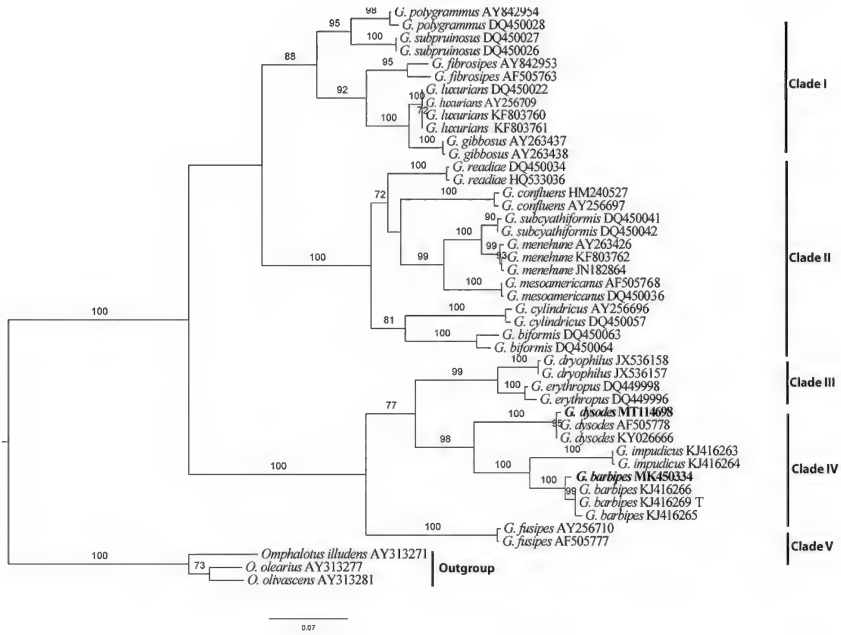

FIG. 3. Molecular phylogenetic analysis of *Gymnopus* sequences by the Maximum Likelihood method. The bootstrap consensus tree inferred from 1000 replicates implies the evolutionary history. The percentage of trees in which the taxa cluster together is shown next to the branches. New sequences reported in this study are in **bold; T** = holotype.

G. dysodes. There are no previous reports of *G. dysodes* from the country, which makes this species an addition to the funga of Pakistan.

Gymnopus impudicus (Fr.) Antonín & al., a similar species, can be separated by its darker basidiomata (dark brown pileus and almost black stipe base), fetid (not garlic-like) odour, smaller basidiospores (5.5–7.5 × 3.5–4) µm, and moniliform to coralloid cheilocystidia (20–40 × 3–9 µm; Noordeloos 1995).

Phylogeny

A total of 45 nrITS sequences were used in the molecular phylogenetic analysis, 42 representing 18 *Gymnopus* taxa and three representing three *Omphalotus* in-group taxa (TABLE 1). The final dataset had 935 sites of which 475 were conserved, 454 were variable, and 423 were parsimony informative.

Maximum likelihood analysis clustered the included nucleotide sequences of *Gymnopus* into five well supported clades. Species within the Clades I and II are members of *Gymnopus* subsect. *Vestipedes*. Clade III correlates to *G.* subsect. *Levipedes*, clade IV to *G.* subsect. *Impudici,* and clade V to *G.* sect. *Gymnopus*. Both Pakistani species fall within clade IV (*G.* subsect. *Impudici*). *Gymnopus dysodes* and *G. barbipes* clustered with sequences from USA with strong bootstrap support (100%).

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Agaricus, Steccherinum, and *Typhula* species new for Turkey

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Abstract—Basidiomycetes collected from Tokat and Yozgat provinces during field trips during 2012–18—identified as *Agaricus dulcidulus* (*Agaricaceae*), *Steccherinum oreophilum* (*Meruliaceae*), and *Typhula erythropus* (*Typhulaceae*)—were recorded for the first time for the Turkish mycota. Short descriptions, illustrations, GPS coordinates, and comparisons with similar taxa are provided.

Key words—*Agaricales,* fungal diversity, morphology, *Polyporales*, taxonomy

Introduction

Fungi, among the most diverse organisms in the world, have been estimated to represent approximately 1.5 million species (Hawksworth 2001). Those producing fruitbodies visible to the naked eye are referred as macrofungi, most of which are assigned to two phyla, *Ascomycota* and *Basidiomycota*. Basidiomycetous macrofungi are an important group comprising saprophytic, mycorrhizal symbiotic, and parasitic species that produce fruitbodies in such varied forms as truffles, corals and clubs (clavarioid fungi), jellies, bird's nests, puffballs, conks (shelf fungi), and agarics (gilled fungi) (Andrew & al. 2013; Kinge & al. 2017).

Research on the macrofungal diversity of Turkey, which was first conducted by Vlaev (1915) in European Turkey, has continued to the present day. Sesli & Denchev (2014) reported that 1943 basidiomycetous macrofungal species had been recorded for Turkish mycota up through the end of 2014. Other scientists have also contributed to basidiomycetous macrofungal diversity of Turkey and increased this number (Kaya 2015;

Sesli & al. 2015, 2016; Akata & Sesli 2017; Işık & Türkekul 2017, 2018a,b; Sesli & Vizzini 2017; Türkekul 2017; Uzun & Demirel 2017; Uzun & al. 2017, 2018a,b; Akata & Gürkanlı 2018; Akata & al. 2018; Sesli 2018; Uzun & Acar 2018; Uzun & Kaya 2018a,b; Keleş 2019a,b).

This study should contribute additional knowledge of basidiomycetous macrofungal diversity in Turkey.

Materials & methods

Fresh basidiomata were carefully collected from Akdağmadeni (Yozgat) district and Yaylacık Mountain (Tokat) during 2012–18. The specimens were photographed in the field, and their macroscopic features and ecological features were noted. The fresh specimens were brought to the laboratory, assigned collection numbers, dried thoroughly with an electric heater, and placed into polyethylene bags for further study. Microscopical structures (basidia, basidiospores, cystidia, hyphae) were examined under a compound light microscope in mountants prepared with Melzer's reagent, distilled water, Congo red, methylene blue solution, and KOH. The specimens were identified based on their macroscopic, microscopic, and ecological features by consulting the literature (Moser 1983; Breitenbach & Kränzlin 1986, 1991; Niemelä & Saarenoksa 1985; Niemelä 1998; Noordeloos & al. 2001; Phillips 1981, 2013; Læssøe 1998; Sanyal & al. 2016; Loizides 2017; Putzke & Putzke 2017). The examined specimens were deposited in the Fungarium of the Biology Department, Gaziosmanpaşa University, Tokat, Turkey (ISIK).

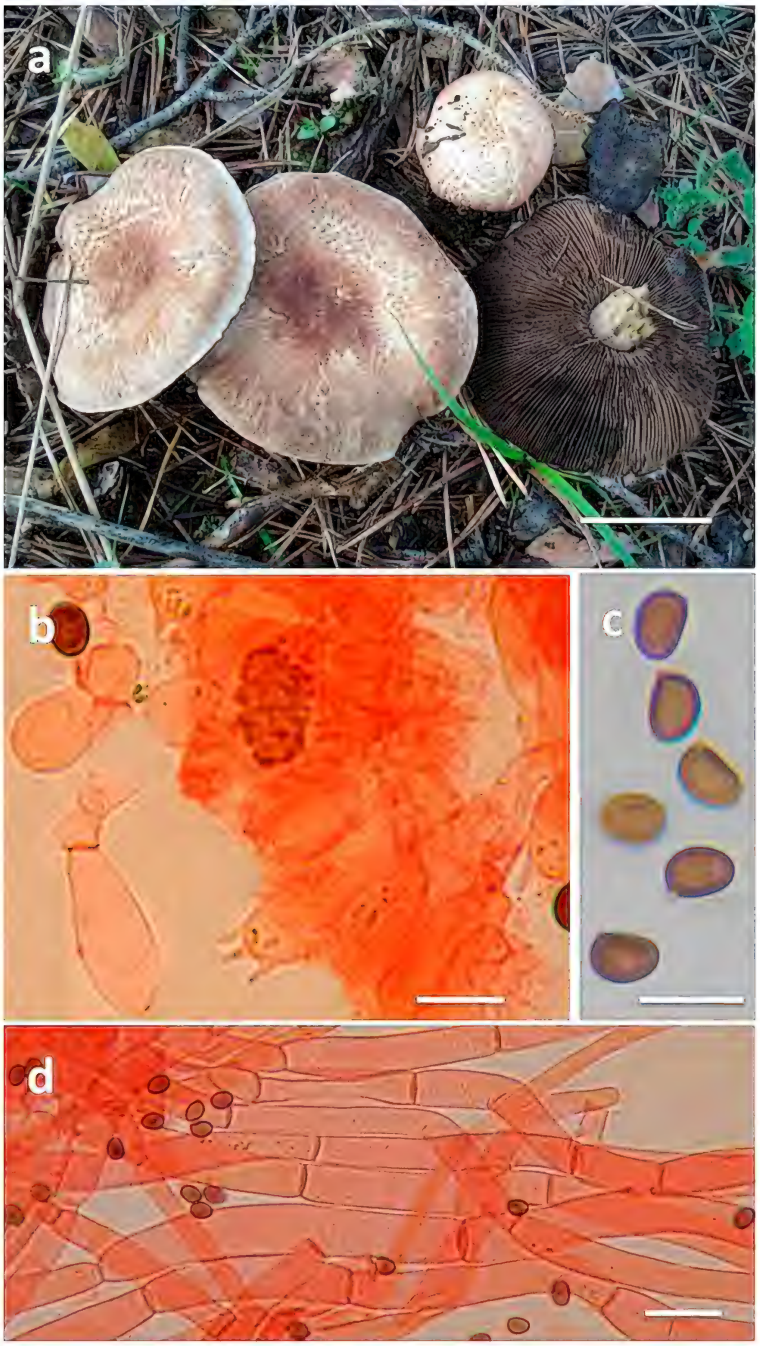
Taxonomy

Agaricus dulcidulus Schulzer, Icon. Sel. Hymenomyc. Hung. 2: 29 (1874) Fig. 1

Pileus 20–70 mm diam., ovate at first, later plane to sometimes umbonate, depressed when old, white when young with brown squamules, later lilaceous to vinaceous brown fibrillose with vinaceous brown or purplish brown disk on white ground, white at margin. Lamellae free, close, pinkish brown at first, later dark brown with whitish edge. Stipe (20–)30–85(–90) × (2–)4–8(–10) mm, central, cylindrical to clavate, bulbous at base, white, yellowish towards base, smooth to fibrillose, annulate. Annulus white, membranous, pendant. Spore print brown.

Basidiospores (4.2–)5–6(–6.5) × (3.1–)4.5–5 µm, ellipsoidal, smooth, inamyloid. Basidia, (19–)22–23(–23.2) × (6–)6.5–6.8(–7) µm, clavate, 4-spored. Cheilocystidia abundant, pyriform to broadly clavate or clavate. Pleurocystidia absent. Clamp connections absent.

Fig. 1. *Agaricus dulcidulus* (ISIK 225): A. basidiomata in situ; B. cheilocystidia and basidium; C. basidiospores; D. hyphae of pileipellis. Scale bars: A = 3 cm; B, C = 10 µm; D = 20 µm.


a
b
c
d

Specimen examined: **TURKEY, Yozgat, Akdağmadeni,** 39°39′95″N 35°56′04″E, 1580 m, among needle litter in *Pinus sylvestris* L. (*Pinaceae*) forest, 27 May 2012 (ISIK 225).

Comments—Although some spores in our specimens are larger, the macro- and micromorphological characters otherwise agree with those cited by Moser (1983), Noordeloos & al. (2001), Phillips (2013), and Putzke & Putzke (2017).

Agaricus dulcidulus (Agaricaceae) is morphologically close to *A. porphyrizon* P.D. Orton and *A. semotus* Fr., but *A. porphyrizon* is separated by its bigger pileus, longer stipe, and habitat preference, growing mostly in deciduous forests (Noordeloos & al. 2001, Phillips 2013). *Agaricus semotus,* which also grows in deciduous forests or among grasses, differs from *A. dulcidulus* by its white to light brown pileus with lilac to reddish-violet fibrillose scales (especially in the centre), double ring, smaller spores, and purple-brown spore print (Phillips 1981, Breitenbach & Kränzlin 1991, Lacheva & Radoukova 2014).

Steccherinum oreophilum Lindsey & Gilb., Mycologia 69(1): 194 (1977) Figs 2,3

Pileus white, effused-reflexed, resupinate, glabrous, stipeless, 6–10 mm broad, margin sinuate when mature, hymenophore odontoid, concolorous with basidiocarp surface. Aculei irregularly flattened and sometimes subulate, confluent or simple, 0.4–2.3 mm long, creamy whitish. Hyphal system dimitic; generative hyphae with clamp connections, thin-walled; skeletal hyphae ≤4(–4.5) µm diam., aseptate, thick-walled.

Basidiospores (5.5–)6–6.5(–7) × (3–)3.2–3.5(–3.9) µm, ellipsoid, smooth, inamyloid. Skeletocystidia long, deep-rooting and tapering (carrot-like), apically encrusted, (79–)85–120(–123) × (6.2–)7–7.5(–9.8) µm. Basidia (9.6–)11.5–16.5(–17.2) × (4–)4.2–4.8(–5) µm, clavate, 4- spored, with basal clamp connections.

Specimen examined: **TURKEY, Tokat, Yaylacık mountain,** 40°31′12″N 36°40′36″E, 1211 m, on fallen and rotten branches of *Fagus* sp. (*Fagaceae*), 27 June 2018 (ISIK 769)

Comments—The specimen we identified as *Steccherinum oreophilum* (*Meruliaceae*) agrees with the literature (basidiospores: 6–6.8 × 3.8 µm, Niemelä & Saarenoksa 1985; 5–6.4 × 2.4–3 µm, Sanyal & al. 2016; 5.5–7 × 2.5–3.5 µm, Loizides 2017).

Morphologically, *S. oreophilum* is similar to *S. ochraceum* (Pers. ex J.F. Gmel.) Gray, *S. bourdotii* Saliba & A. David, and *Irpex lacteus* (Fr.) Fr. Matted pileal surface, cylindrical spines, and smaller basidiospores separate *S. ochraceum* from *S. oreophilum.* In addition to the tomentose pileal surfaces

Fig. 2. *Steccherinum oreophilum* (ISIK 769): A. basidiomata; B. basidium and basidiole; C. basidiospores. Scale bars: A = 1 cm; B, C = 10 μm.

of *S. bourdotii* and *I. lacteus,* distinguishing characters include slightly smaller and cylindric spores, an absence of clamp connections, and less strongly encrusted cystidia for *I. lacteus,* while the cylindrical spines and subglobose spores separate *S. bourdotii* from *S. oreophilum* (Niemelä & Saarenoksa 1985, Niemelä 1998).

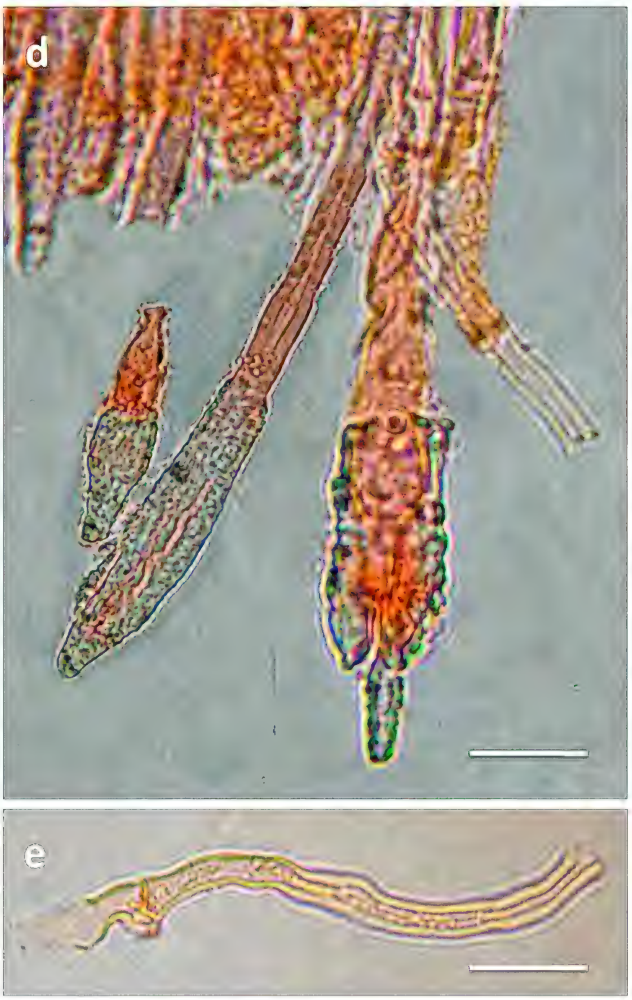
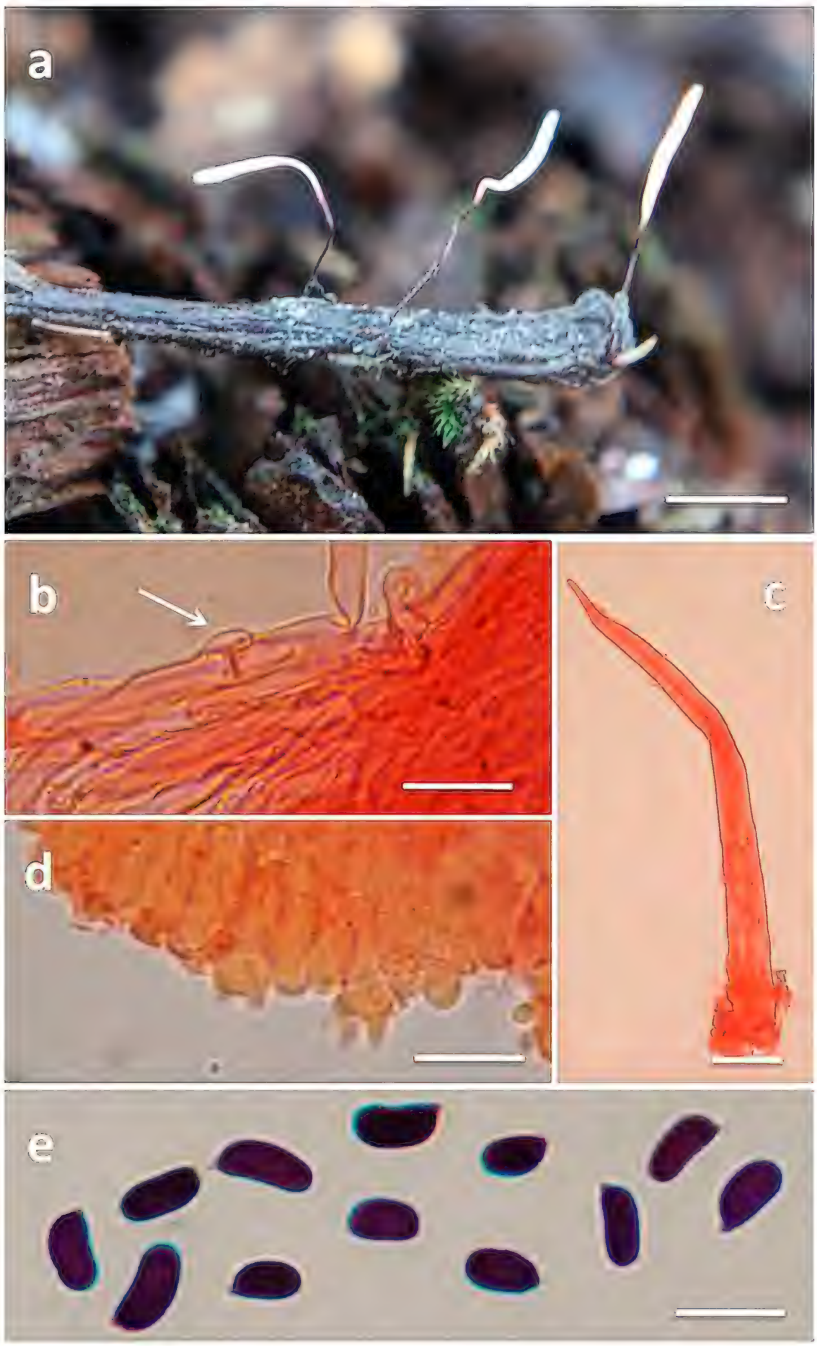


Fig. 3. *Steccherinum oreophilum* (ISIK 769):
D. skeletocystidia; E. hypha with clamp. Scale bars = 10 µm.

Typhula erythropus (Pers.) Fr., Observ. Mycol. 2: 297 (1818) Fig. 4

Fruiting Body (5–)10–30 mm, comprising a fertile head and a long stalk. Fertile head white to creamy white, cylindrical to clavate, smooth. Stalk 0.1–0.3 mm thick and 10–20 mm long, filiform, bended, slender pubescent, cartilaginous, hollow, deep reddish, lighter red towards the apex, arising from

Fig. 4. *Typhula erythropus* (ISIK 751): A. basidiomata; B. stipe hypha with clamp; C. stipe hair; D. basidia; E. basidiospores. Scale bars: A = 1 cm; B, D, E = 10 µm; C = 40 µm.


a
b
c
d
e

a buried blackish sclerotium. Hairs 260–290 × 25–27 µm, pointed at apex, wide at base. Flesh white, transparent especially in fertile head, soft, very thin. Spore print white.

Basidiospores (5–)5.5–9(–9.7) × (2.1–)2.5–3(–3.8) µm., elliptical to oblong, sometimes elongated, smooth. Cheilocystidia not found. Caulocystidia hyaline, thick-walled, subulate, septate. Basidia slightly clavate, 25–40 × 5–6(–6.7) µm, 4-spored, with basal clamp.

Specimen examined: **TURKEY, Tokat, Yaylacık mountain,** 40°31′07″N 36°39′24″E, 1298 m, on fallen leaves and dead branches of *Alnus* sp. (*Betulaceae*), 4 November 2017 (ISIK 751).

Comments—The features of our collected specimen are compatible with published descriptions of *Typhula erythropus* (Phillips 1981, Læssøe 1998, Breitenbach & Kränzlin 1986).

Typhula erythropus (*Typhulaceae*) is easily recognizable by its white club and its red-brown stalk. *T. erythropus* and *T. phacorrhiza* (Reichard) Fr. may be confused with each other due to their similar ecological features, but *T. phacorrhiza* is distinguishable by its longer and honey-yellow fruiting body, absence of an evident club, and bigger basidiospores (Breitenbach & Kränzlin 1986).

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Tubakia koreana sp. nov. causing *Quercus* leaf blight

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Abstract — A new species, *Tubakia koreana* (*Diaporthales*, *Ascomycota*), isolated in Korea from blight symptoms on *Quercus* leaves, is described and illustrated. The species is morphologically distinct from other *Tubakia* species and causes a progressive necrotic leaf blight that differs from leafspot symptoms caused by other species. Phylogenetic analysis of ITS sequences supports a monophyletic *T. koreana* clade independent of other *Tubakia* species.

Key words — leaf death, *Quercus acutissima, Quercus mongolica*, sawtooth oak

Introduction

Oaks (*Quercus* spp.), which are widely distributed in the northern hemisphere, are the most common tree species in Korea, occurring in ~27% of the mountainous area. Four species of *Tubakia* have been reported in Korea: *T. japonica* (Sacc.) B. Sutton (on *Castanea crenata*, *Quercus acutissima*, and *Q.* × *alienoserratoides*), *T. rubra* (T. Yokoy. & Tubaki) B. Sutton (on *Q. serrata*), and an undescribed *Tubakia* sp. (on *Q. rubra*; Cho & al. 2004); and *Tubakia seoraksanensis* H.Y. Yun (on *Q. mongolica*; Yun & Rossman 2011). In search of more *Tubakia* species, we surveyed various regions in Korea; in the mountain localities of several South Korean provinces leaf blight symptoms were observed from September 2009 through November 2014 on four species: *Q. acutissima*,

Q. × *alienoserratoides, Q. mongolica*, and *Q. serrata*. There had been no previous report of severe foliar blight symptoms of oaks in Korea. The symptoms were similar to those of bur oak blight in U.S.A., caused by *T. iowensis* T.C. Harr. & McNew (Harrington & al. 2012). In this study, the causal agent of the Korean oak leaf blight was examined to determine its morphological and molecular genetic characteristics. It was compared with other *Tubakia* species for identification of the fungus, which is described below as *T. koreana*.

Materials & methods

For fungal isolation, conidiomata on leaves of *Quercus* spp. with blight symptoms were detached from the adaxial leaf areas along the necrotic mid- and lateral veins and cultured on malt extract agar (MEA, 1.5% malt extract, and 2% agar) at 25°C in the dark. Fungal hyphae growing out of the conidiomata were harvested and sub-cultured on fresh MEA at 25°C for 14 days, at which time mycological characteristics were examined. For detailed morphological study, microscopic structures of the fungus growing on MEA were examined under a Zeiss Axiophot compound light microscope. Color of cultures was described using Munsell soil color charts (Munsell 2000). Voucher specimens were deposited in the Herbarium of the Korean Forest Research Institute, Seoul, South Korea (HKFRI), and cultures were conserved in Jengeup-si, Jeollabuk-do, South Korea (KCTC).

For DNA extraction, PCR, and DNA sequencing, fungal cultures grown on MYEA (2% malt extract, 0.2% yeast extract, and 1.5% agar) at room temperature for 14 days were used. Methods for DNA extraction, PCR (including primers), and sequencing of ITS rDNA followed Yun & Rossman (2011). ITS sequences were deposited in GenBank. The ITS sequences for our isolates along with other known *Tubakia* species were preliminarily aligned using Clustal X version 2.1 under default settings (Thompson & al. 1997). The alignment was edited using Mesquite 3.03 beta 2 (Maddison & Maddison 2015). *Greeneria uvicola* was used as outgroup for *Tubakia* since this species was among the closest to genus *Tubakia* based on BLAST search at the National Center for Biotechnology information (NCBI; https://www.ncbi.nlm.nih.gov). Maximum parsimony analysis (MP) was conducted using PAUP version 4.0b10 (Swofford 2002), using a heuristic search with the starting tree obtained via stepwise addition with random addition of 1000 replicates, tree–bisection–reconnection (TBR) as the branch swapping algorithm, and MULTREES off. All characters were unordered, whereas equal weights and gaps were treated as a fifth character. Stability of the clades (bootstrap) was assessed with 1000 replicates using the same MP settings. Bootstrap values greater than or equal to 70% were considered significant (Hillis & Bull 1993). Pathogenicity tests of *Tubakia koreana* on *Quercus acutissima* were performed using inoculation protocols modified from those of Harrington & al. (2012).

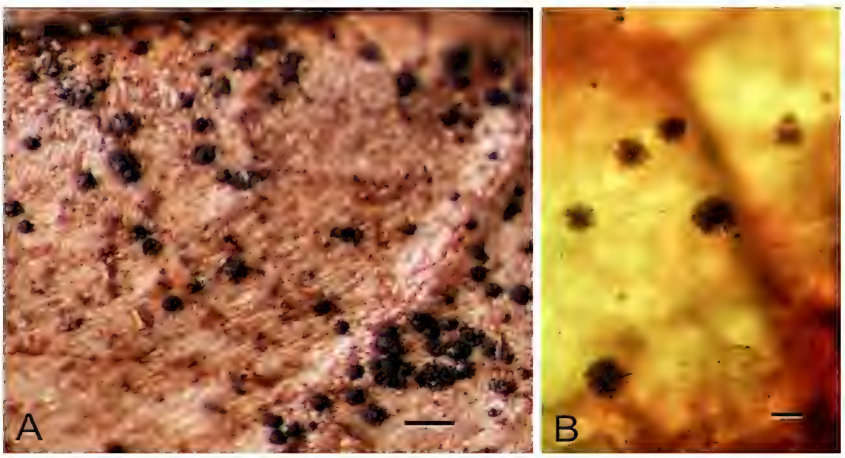

Fig. 1. *Tubakia koreana* (HKFRI4072) on *Quercus acutissima*: Sign of the blight, black crustose conidiomata. Scale bars: A = 1 mm; B = 0.5 mm.

Taxonomy

Tubakia koreana H.Y. Yun, **sp. nov.** Plates 1. 2

MB814540

Differs from *Tubakia dryina* by its brown colony color and its bigger spore size.

Type: South Korea, Gyeonggi: Mt. Geom-dan, Hanam-si, Sinjang-dong, living tree of *Q. mongolica* Fisch. ex Ledeb., 18 July 2012, HY Yun, HY946 (**Holotype**, HKFRI 4073; ex-type culture, KCTC 46072; GenBank KP886837).

Etymology: *koreana* refers to the country where the species was collected.

The fungus was consistently isolated from leaves with blight symptoms produced in nature and by artificial inoculation. Small crustose conidiomata with radiate scutella formed on the necrotic tissues of mostly the upper side or occasionally on both sides of leaf surfaces. The fungal colonies fully grown on malt extract agar (MEA) at 25°C were felt-like and very pale brown to brown in color with concentric rings of dense aerial mycelium and a scalloped margin. Scutella that formed on leaf surfaces were 60–180 × 55–120 µm, membranous, composed of thick-walled, pale brown to brown, septate hyphae radiating, typically bifurcating up to three times from a central disc that consisted of a single hyaline cell towards the margin, acute and cornuted at the margin that was fringed and unattached to the substrate. Conidia were 8.5–14.5 × 6–10 µm, blastic, subglobose, broadly

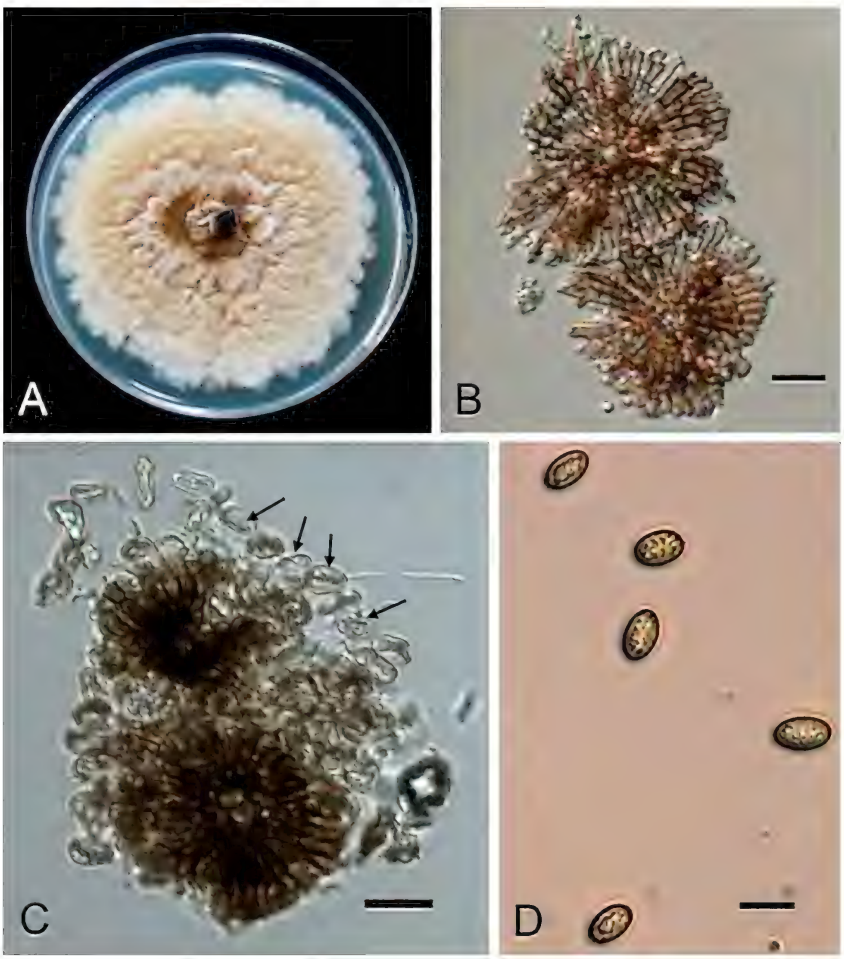

Fig. 2. *Tubakia koreana* (HKFRI4073). A. Colony grown on malt extract agar at 25°C for 14 days; B. Scutella; C. Scutella and conidia (arrows); D. Conidia. Scale bars: B = 50 µm; C = 20 µm; D = 10 µm.

ellipsoid to ellipsoid, and hyaline. They were turning pale yellowish brown, and the walls were smooth. Microconidium was not observed.

Additional specimens examined: **SOUTH KOREA**: **Chungbuk**, **Buk-myeon,** Inje-gun, living tree of *Quercus mongolica*, 5 July 2012, HY Yun, HY882 (HKFRI4083); **Jeungpyeong-gun,** Jeungpyeong-eup, Miam-ri, living tree of *Q. acutissima* Carruth., 18 July 2012, HY Yun, HY1095 (HKFRI4090, KCTC46103), HY1096 (HKFRI4091,

KCTC46104), HY1098 (HKFRI4081, KCTC46105); living tree of *Q. serrata* Murray, 18 July 2012, HY Yun, HY1097 (HKFRI4082). **Gangwon**, **Wonju-si,** Halla Univ., Heungeop-myeon, Heung-eop-ri, living tree of *Q. mongolica*, 6 October 2012, HY Yun, HY134 (HKFRI4086); **Sokcho-si,** Mt. Seorak, Seorak-dong, living tree of *Q.* × *alienoserratoides* T.B. Lee, 28 October 2011, HY Yun, HY719 (HKFRI4071, KCTC46044, GenBank KP886836); Seoraksan National Park, Seorak-dong, living tree of *Q. acutissima,* 31 Aug. 2009, HY Yun, US227 (HKFRI4085); **Gyeonggi**, **Namyangju-si,** Mt. Un-gil, Songchon-ri, Joan-myeon, on living tree of *Q. mongolica,* 27 July 2012, HY Yun, HY989V (HKFRI4089, KCTC46092); **Jeonbuk**, **Muju-gun,** Mt. Deog-yu, Samgong-ri, Seolcheon-myeon, living tree of *Q. mongolica*, 10 July 2012, HY Yun, HY190 (HKFRI4070; KCTC46031; GenBank KP886834); **Jeonnam, Gwangyang-si,** Ongnyong-myeon, living tree of *Q. acutissima*, 24 February 2012, HY Yun, HY107 (HKFRI4084); **Seoul**: **Seoul,** Mt. Kwan-ak, Gwanak-gu, Daehak-dong, living tree of *Quercus acutissima*, 23 June 2012, HY Yun, HY816 (HKFRI4072, KCTC46051, GenBank KP886835).

Discussion

Initial symptoms were small pale-brownish and dehydrated areas on leaves that spread through leaf veins and blades until the entire leaf or large areas were blighted with necrotic mid and lateral veins. Those symptoms sometimes preceded premature defoliation. The mycological characteristics of the present pathogen were distinct from those of other *Tubakia* species; i.e., colony color (very pale brown to brown) differing from *T. dryina* (Sacc.), B. Sutton (light gray), *T. iowensis* (light and dark gray), and *T. seoraksanensis* (whitish to pale yellow); conidial size smaller than *T. seoraksanensis*; and an absence of microconidia unlike their occasional presence in *T. iowensis* (Harrington & al. 2012, Yun & Rossman 2011). Also, ITS rDNA sequence analysis of the four isolates from diseased oak trees showed they had identical sequences. In addition, phylogenetic analysis placed this fungus in a monophyletic lineage independent of other *Tubakia* species (Plate 3).

Maximum likelihood tree comparison revealed it is a unique monophyletic clade, distinct from other *Tubakia* species. Also, the observed symptom of severe necrosis is different than the symptom of leaf spots observed in *T. japonica*. The Korean *Tubakia* species has much smaller conidia than *T. japonica*. These observations all suggest that the causal agent of oak leaf blight in the present studies is a new *Tubakia* species with different mycological and genetic characteristics from other *Tubakia* species distributed worldwide. The species epithet is named *koreana* to indicate a pathogen that is prominent throughout the mountains of South Korea. The disease caused by this fungus should be named oak leaf blight,

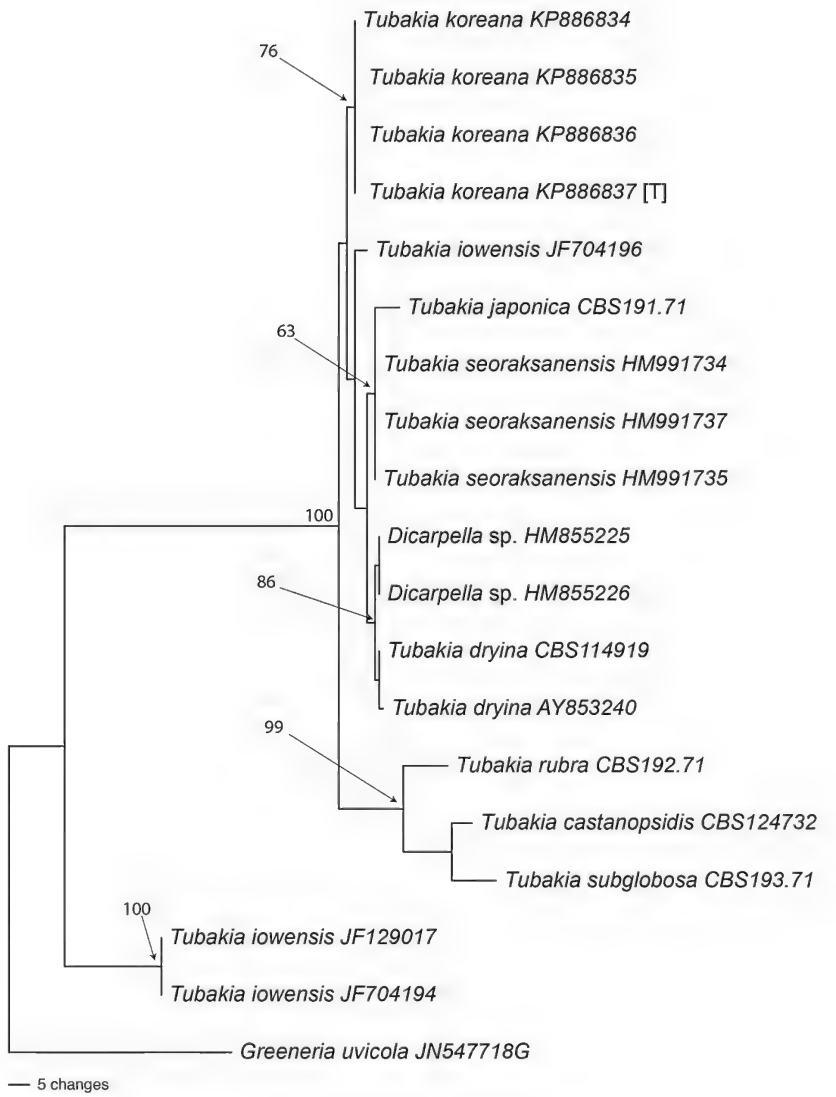

FIG. 3. Maximum likelihood tree produced from selected ITS rDNA sequences, showing the relations of *Tubakia koreana* isolates with other *Tubakia* species, [T]: holotype. The tree was obtained using PhyML 3.0. Numbers above the branch points are bootstrap values obtained from 1000 replicates.

rather than oak blight, since twig and branch dieback symptoms were rarely found, as in the bur oak blight reported in the U.S.A. (Harrington & al. 2012). In pathogenicity tests, leaf blight symptoms similar to naturally occurring symptoms developed on all oak trees wound-inoculated (mid vein) with conidial suspensions of *T. koreana* 15 days after inoculation; the most severe symptoms were observed on *Q. acutissima*. Oak trees are common tree species in Korea. Therefore, this disease could be a potential threat to the stable ecological succession of Korean forest vegetation.

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Regional annotated mycobiota new to the Mycotaxon website

SUMMARY—In February, MYCOTAXON added the 136th annotated species distribution list to our previously posted fungae. The 23-page "Macrofungi from the Hebron and Jerusalem Hills of Palestine" by Maximus Thaler, Aysha Al-Wahsh, Alea Meuser, Alyssa Rooks, and Mazin Qumsiyeh may be downloaded (for no charge) from our website via http://www.mycotaxon.com/mycobiota/index.html

MID-EAST

Palestine

MAXIMUS THALER, AYSHA AL-WAHSH, ALEA MEUSER, ALYSSA ROOKS, MAZIN QUMSIYEH. Macrofungi from the Hebron and Jerusalem Hills of Palestine. 23 p.

ABSTRACT—This study is based on specimens of macrofungi collected from biodiversity hotspots in the southern West Bank of occupied Palestine during a four-week survey period in December and January 2018–19. We identified 27 macrofungi species representing 39 genera from six field sites. Samples were collected, photographed, and archived in the Palestine Museum of Natural History herbarium. Species descriptions, field site details, and a cladogram of the observed fungi are provided. The importance of citizen science and accessible taxonomic inquiry is also discussed.

KEY WORDS—diversity, mycota, taxonomy

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Regional annotated mycobiota new to the Mycotaxon website

Abstract—Mycotaxon is pleased to add a new annotated species distribution list to our 136 previously posted free-access fungae. The 29-page "Checklist of Bolivian *Agaricales*. 2: Species with white or pale spore prints" by Melgarejo-Estrada, Rocabado, Suárez, Maillard, and Lechner may be downloaded from our website via http://www.mycotaxon.com/mycobiota/index.html

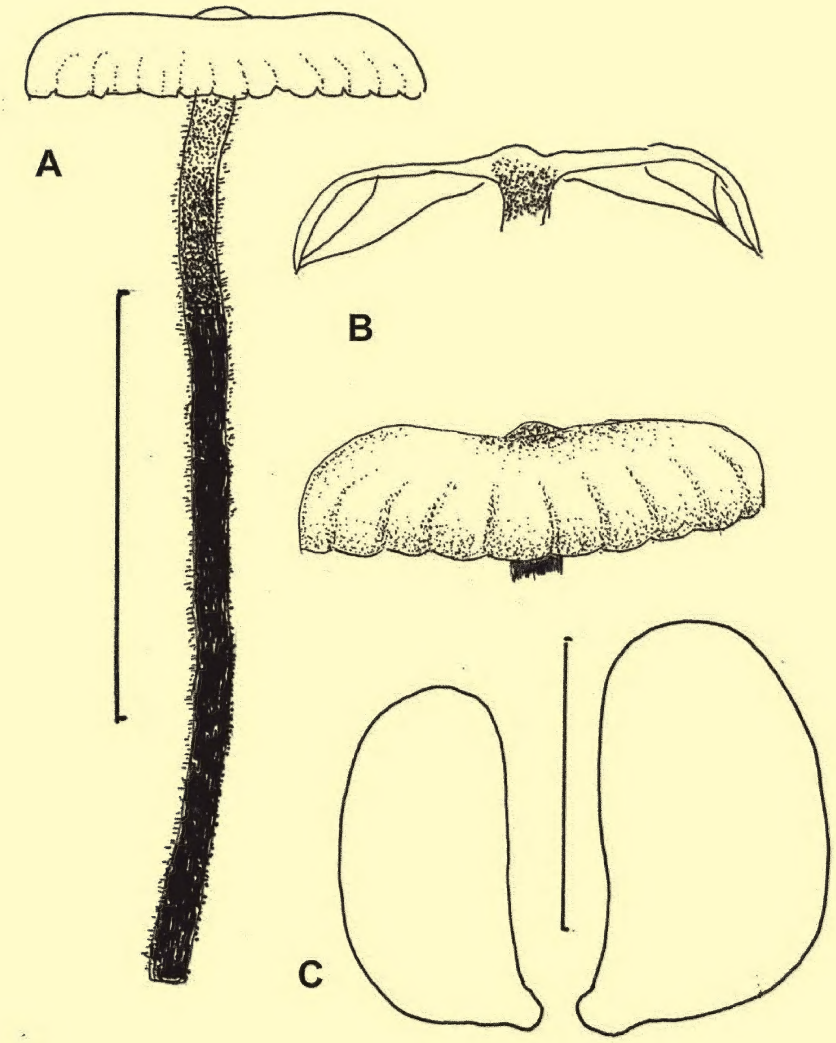
SOUTH AMERICA

Bolivia

Elizabeth Melgarejo-Estrada, Diana Rocabado, María Eugenia Suárez, Oswaldo Maillard, Bernardo Ernesto Lechner. Checklist of Bolivian Agaricales. 2: Species with white or pale spore prints. 29 p.

Abstract—We provide a literature-based checklist of Agaricales reported from Bolivia. In this second contribution, 264 species belonging to 55 genera and 15 families (*Agaricaceae, Clavariaceae, Cyphellaceae, Hygrophoraceae, Hymenogastraceae, Marasmiaceae, Mycenaceae, Omphalotaceae, Physalacriaceae, Pleurotaceae, Pterulaceae, Schizophyllaceae, Tricholomataceae,* and *Typhulaceae*) are listed. Of these, *Marasmiaceae, Omphalotaceae,* and *Hygrophoraceae* were the most species-abundant families. Some new local distribution records are documented in this checklist. The lichens *Cora* and *Dictyonema* are also included in the present checklist.

Key words—*Basidiomycota,* distribution, diversity, fungi, Neotropics, South America



Pseudomarasmius quercophiloides sp. nov.
(Petersen & Hughes— FIG. 49, p.73)
RONALD H. PETERSEN, *artist*